University of Kwa-Zulu Natal

Leader development approaches that engender leadership effectiveness among natural scientists in Uganda—a comparative study

by

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DECLARATION

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Abstract

Most natural scientists are promoted into leadership positions based on technical competence, yet technical capabilities become less vital as leadership responsibility increases. While scientists need to adopt leader development approaches that engender leadership effectiveness, this area is not well understood. Previous studies have pointed to a dearth of literature on effective leader development approaches, bemoaning the struggles organisations and leaders face in identifying appropriate methodologies and the attendant costs associated with the typical haphazardness. This mixed-methods, sequential explanatory, comparative study aimed to examine the experiences of leadership development among natural scientists in supervisory positions and the relationship between development approaches and perceived leadership effectiveness. The study applied a constructionist lens and used the theory of expert leadership as the central frame, with social identity and planned behaviour as secondary theories to explain some of the antecedents of effective expert leadership. The study integrated quantitative analysis of a cross-sectional survey of 221 Ugandan leaders with the thematic analysis of data from two focus groups and semi-structured qualitative interviews among 21 scientists and 11 non-scientists. The study provides new insights into the leader development phenomenon, specifically in how leadership conceptualisation, attitudes, beliefs, social-identity, self-efficacy, subjective norms and organisational culture, systems and policies impact the appetite for leader development. The study demonstrated a dose-response relationship where leaders highly exposed to mentorship, feedback, e-learning or formal leadership training were significantly more likely to have higher leadership effectiveness. The study found that coaching, mentorship, feedback, formal leadership training, acting in a leadership role, and experiential learning appear to be more impactful in nurturing leadership skills among natural scientists. Despite the limitations of a small sample, the study identified specific applications of these leader development approaches that make them engender leadership effectiveness. The study concludes by recommending the ABC model of leader development. The model could be useful in guiding leaders, educators and policy elites responsible for engineers, physicians and agriculturalists to design more effective leader development programmes.

Key words: Effective leader, Expert leadership, Leader development, Leadership development, Physician leadership

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List of abbreviations

ABC	Approach Beliefs Context model of leader development
ANOVA	Analysis of Variance
CIA	Central Intelligence Agency
COVID-19	2019 Novel Coronavirus Infectious Disease
DNA	Deoxyribonucleic Acid
DOI	Digital Object Identifier
EBSCO	Business Source Corporate database
EFMD	European Foundation for Management Development
EL	Expert Leadership
FGD	Focus Group Discussion
GAPR	Uganda Government Annual Performance Report
GDP	Gross Domestic Product
HR	Human Resources
HSSREC	Humanities and Social Sciences Research Ethics Committee
ICT	Information Communication Technology
IE	Industry Experience
IK	Inherent Knowledge
ISSN	International Standard Serial Number
L&D	Learning and Development
LC	Leadership Capabilities
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MOOC	Massive Open Online Courses
NGO	Non-Governmental Organization
NOCA	Network of Corporate Academies
NVivo	Statistical & Qualitative Data Analysis Software.
OPM	Office of the Prime Minister
PAU	Petroleum Authority of Uganda
RCT	Randomised Controlled Trials
SCIMAGO	SCImago Journal & Country Rank portal
SCOPUS	Bibliographic database for peer-reviewed literature
SHRM	Society for Human Resource Management
SOP	Standard Operating Procedures
SPSS	Statistical Package for the Social Sciences
STEM	Science, Technology, Engineering and Maths
TEL	Theory of Expert Leadership
TPB	Theory of Planned Behavior
UKZN	University of Kwa-Zulu Natal
UNCST	Uganda National Council for Science and Technology
UNRA	Uganda National Roads Authority
URA	Uganda Revenue Authority
VUCA	Volatility, Uncertainty, Complexity, and Ambiguity
WHO	World Health Organization

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CHAPTER ONE — INTRODUCTION

1.1 Introduction

This chapter provides the roadmap to the thesis, outlining the problem and context of the study, the research questions and objectives and the conceptual framework that guides the study. It also highlights the nature and significance of the study. The chapter concludes with an outline of the chapters that make up the thesis.

As leadership effectiveness becomes recognised as a central pillar in any organisation's success, natural scientists from disciplines such as engineering, agriculture, and medicine are increasingly looking for approaches that engender the nurturing of leadership skills. Until recently, natural scientists like physicians and engineers had ignored the value of leader development and focused mostly on technical competence development (Guthrie, 1999; Stoller, 2009; Rice *et al.*, 2020). However, while existing literature provides some insight into what approaches work in leader development, despite the recognised influence of context, most of the research has been conducted in developed country contexts, and moreover, overly focused on non-scientist leaders (Stoller, 2008; Day *et al.*, 2014; DeRue and Myers, 2014; Geerts, Goodall and Agius, 2020). Additionally, the few studies conducted have mostly been siloed into specific sub-disciplines within the natural sciences field, for example, looking at only engineers or only physicians or nurses, thereby diminishing our understanding of the collective characteristics of the leader development phenomenon among natural scientists as a group (Collins and Holton, 2004; Blumenthal *et al.*, 2012; Funari, Feider and Schoneboom, 2015; Goodall and Stoller, 2017; Perry *et al.*, 2017). This study adds to the literature by examining the question of how leaders develop in the natural sciences by integrating perspectives from multiple science sub-disciplines (engineering, medicine, agriculture) and particularly in the developing country context. The current study uses a retrospective mixed-methods multi-case comparative case study approach to examine the leader development lifespan experiences of technical expert scientists holding leadership positions in organisations at the forefront of healthcare, engineering and agriculture in Uganda and how such experiences differ from non-scientist leaders at a comparable organisation.

The study aims to identify leader development approaches associated with higher leadership effectiveness levels among leaders holding supervisory positions in natural science settings. Using the theory of expert leadership, social identity theory and the theory of planned behaviour, the current study applies a constructionist lens to the questions: how do leader development approaches among natural scientists differ from those of non-scientists? Furthermore, what specific approaches engender leadership effectiveness and why? Through the thematic analysis of semi-structured qualitative interviews and the quantitative analysis of a cross-sectional survey, the current study presents findings on the relative prevalence and perceived efficacy of various leader development approaches. The qualitative data include interviews among 21 scientist leaders and 11 non-scientist leaders, and two Focus Group Discussions (FGDs). The quantitative data include a cross-sectional survey of 221 respondents. The study also provides insights into the contextual factors specific to natural scientists that affect leader development. The study concludes by suggesting approaches that leaders and policy elites in various natural scientist fields could advance to create an environment that engenders leader development.

The study contributes to the literature by providing new insights into the leader development phenomenon, specifically in how—within the context of natural sciences and a developing country setting—leadership conceptualisation, leader-identity, self-efficacy, structural limitations, and subjective norms, meaningfully attenuate the appetite for engagement in leader development activities. Additionally, the current study expands the application of Ajzen's (1991) theory of planned behaviour and proposes an emerging conceptual framework that could be a useful tool for future research. Such research could increase our understanding of the interplay between contextual influences, leader characteristics and the traditional aspects of Ajzen's (1991) model—attitudes, social norms, perceived behavioural control, intention and behaviour. Besides contributing to the literature, the study also contributes to practice by recommending how natural scientists like doctors and engineers in a developing country context could be supported to develop leadership skills. Specific approaches that create an environment that engenders the learning of leadership—such as policy and organisational culture adjustments, undergraduate school curriculum revisions and mindset change to elevate the value attached to soft-skills, are recommended. The study also provides a tool for assessing leadership competences, exposure to leader development activities, and leader attitudes and beliefs that impact the intention to participate in leader development.

1.2 Background to the study

Leadership effectiveness is an essential factor in the performance of any organisation or industry (Dionne *et al.*, 2004; Boaden, 2006). Evidence in existing literature speaks to a process that can nurture and develop leadership competences (McWhorter, Lynham and Porter, 2008; Backus *et al.*, 2010; Howard and Wellins, 2010; Byham and Sinar, 2014), a subject that has been of much interest to researchers and organisations (Martineau, 1997; Burgoyne, Hirsh and Williams, 2004). Despite widespread research on leadership, many scholars suggest that additional research is needed to understand better the skills needed by leaders (Burgoyne, Hirsh and Williams, 2004; Mumford, Campion and Morgeson, 2007; Farr and Brazil, 2009; Brungardt, 2011; Chuang, 2013) and the most effective ways to develop them (Avolio and Gardner, 2005; Ryan, 2008; Avolio *et al.*, 2009). Even then, this call for additional research has primarily been for leadership in general, not within highly technical fields such as natural sciences and much less in Africa (Gumede, 2017). Even for some natural sciences disciplines like healthcare, where interest in leader development has been significant, "it remains unclear which interventions are most reliably associated with positive outcomes" (Geerts, Goodall and Agius, 2020, p. 1). Whereas there has been some interest in approaches for leadership skills development among technical personnel in the developed world (Burgoyne, Hirsh and Williams, 2004; Winter Institute, 2007; Llorens, 2009; Goodall and Carmichael, 2018), limited research has focused on Africa (Dovey, 2002; James, 2008; Olalere, 2015). Therefore, a deeper understanding of approaches that can enable organisations to nurture and develop leaders in natural science fields to higher levels of effectiveness is needed.

1.2.1 Study setting, population and sample

Often branded the Pearl of Africa, Uganda is a landlocked country in East-Central Africa with an estimated 45 million people and an explosive population growth rate amongst the highest in the world (CIA, 2020). According to the World Bank, Uganda has experienced a slowdown in economic growth and continues to face challenges in reducing poverty, particularly among the youth, who make up 78 per cent of the population (The World Bank, 2020). Past economic growth has been attributed to advancement in the agriculture sector, which employs 72 per cent of the workforce but is experiencing considerable pressure due to flooding, locust invasions and the COVID-19 pandemic crisis. The human capital index is considered low due to inadequate investments in health, education and agriculture, with these sectors relegated to donor financing while the government focuses on infrastructure spending (CIA, 2020). Success in the health and agriculture sector, fields superintended by natural scientists, is therefore critical to the country's progress.

The organisations included in this study are, the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and the Uganda Revenue Authority (URA). MAAIF is included for having a wide range of natural scientists and URA as a comparator organisation employing mostly non-scientists. Additionally, in order to include natural scientists from the health sector, purposive sampling of medical professionals was adopted, drawing an additional sample from the Uganda Medical Association (UMA). The two case organisations were selected because they are comparable (since they are government agencies, and both have a high concentration of technical leaders). Additionally, they are different in their performance levels. The Uganda Government Annual Performance Report (GAPR), produced by the Office of the Prime Minister (OPM), has consistently put MAAIF and its sub-agencies as the poorest performing (Manzil, 2017), while also recognising URA among the best-performing government institutions. Furthermore, these fields represent the frontline of Africa's renaissance. For example, in Uganda, agriculture contributes 25.3 per cent to the GDP and employs 85 per cent of the population (Mugagga, Kakooza and Asiimwe, 2018). MAAIF is also relevant for this study because agriculture is the most important sector in both growth and poverty reduction in Uganda (Joughin and Kjær, 2010). It employs 77 per cent of the rural adult population and accounts for roughly 50 per cent of the merchandise exports (Bategeka, Kiiza and Kasirye, 2013). Despite this importance, agriculture has lagged behind industry and the services sector for the past ten years, ostensibly due to institutional weaknesses in the agricultural sector and the ministry's leadership architecture (Bategeka, Kiiza and Kasirye, 2013).

Whereas the difference in performance levels presents risks in confounding the findings, the similarities in the case organisation—all being government agencies—make MAAIF and URA expedient cases for the study in a setting where a control group is impractical (Goodrick, 2014; Bartlett and Vavrus, 2016). MAAIF is a ministry with four directorates that include Animal Resources, Fisheries Resources, Crop Resources and Agricultural Extension Services. It also has seven semi-autonomous agencies headed by an Executive Director that report to the ministry through the relevant directorates. Leaders at these affiliate agencies are also included in the study.

For the qualitative phase of the study, a sample of 15 participants was selected from each of the participating institutions. However, not all selected participated in the in-depth interviews. The study population includes 26 scientists and 17 non-scientist leaders broken down as follows: 11 leaders from MAAIF (representing agriculture and engineering disciplines) participated in the interviews while five participated in the Focus Group Discussions (FGD), 10 leaders from UMA (representing medicine) participated in the interviews. From the non-scientist group, 11 leaders from URA participated in the interviews and six participated in the FGDs. For the study's quantitative phase, a survey was employed to include all personnel holding leadership positions in the case organisations, with 221 (119 scientists and 102 non-scientists) responding to the survey.

1.3 Problem statement

The transformational power of leadership is well documented, underscoring how excellent leadership is what is needed in an increasingly disruptive, hypercompetitive world (Hartley and Benington, 2010; Drenkard, 2012; Leavy, 2014). Africa continues to lag behind the rest of the world in many respects, including healthcare, engineering, and agriculture, which have a great potential to transform the African people if the leadership within these sectors for example, is improved (Afegbua and Adejuwon, 2012; Gumede, 2017). Leaders in natural science fields are generally promoted into higher leadership positions based on their technical expertise and seniority rather than their leadership competences, yet their new role demands far more leadership skill than technical competence (Hopkins *et al.*, 2006; Stoller, 2009). Moreover, the level of leadership skill required increases with the seniority of the position (Hamm, 2002; Mumford, Campion and Morgeson, 2007). Without fast-tracking leader development amongst this crop of leaders, Africa will continue to lag behind (Ahmed and Hanson, 2011). Little is known about how Africa's scientists can develop leadership competences to transform their organisations to benefit the African people (James, 2008; Dartey-Baah, 2014). This study provides a deeper understanding of how organisations can increase their leader development programmes effectiveness in fields such as healthcare, engineering, and agriculture.

Technical skills have long been given much greater weight in technical fields. However, as globalisation and organisational complexity increases, technical success has increasingly moved from being a function of individual capability and much more the result of many experts collaborating on an interconnected team challenge—escalating the need for leader effectiveness (Goodall and Stoller, 2017; Nyssa, 2019; Baas, Dewhurst and Peyre, 2020). The problem is, while technical competence becomes less of a prerequisite as leadership responsibility increases (Stoller, 2008; Gifford and Finney, 2011; Colcleugh, 2013), little is known about leader development approaches to quickly make excellent technical personnel effective leaders (Stoller, 2008). Perry *et al*. (2017) suggest that whereas technical personnel are competent in their technical areas, they struggle with leadership, partly because of the dismissal of social skills training as right-brain skills and an emphasis on learning technical skills. This is consistent with Sapienza (2004), who argues that the lack of leadership skills amongst those able scientists who cannot lead fellow scientists leads to dismal performance amongst teams of scientists.

A crucial challenge facing Africa is the lack of empirical models for leader development (Kiruhi, 2013). Where approaches have been identified for leader development among expert leaders such as scientists, researchers have limited their research to developed world settings (Guthrie, 1999; Wright *et al.*, 2000; McAlearney, 2005, 2006; Farr and Brazil, 2009). These approaches need to be investigated to select suitable methods and appropriate mechanisms that can be applied to address the leader development challenges among leaders in natural sciences. Several scholars have identified the factors that make it difficult for leaders in technical fields such as the natural sciences to be effective, but this was limited to the medical field (Guthrie, 1999; Davidson *et al.*, 2012; Saxena *et al.*, 2014). Farr and Brazil (2009) have suggested leadership development methods among engineers, and Colcleugh (2013) has provided guidelines for developing leaders among engineers and other scientists in general. However, their research did not provide a model for developing leadership skills, and the research was not done in Africa.

Researchers have called for a deeper understanding of how the context affects leader development (Day, 2000; Mabey, 2013), the interaction between leader development interventions and outcomes (Avolio *et al.*, 2009) and how to more effectively nurture and develop technical expert leaders (Saxena *et al*., 2014). Scholars have particularly called for studies illuminating the process, plans, methods, and models, that institutions in technical fields such as natural sciences can use to develop leaders, and nurture a culture that espouses leadership development (DeRue and Myers, 2014; Miles and Scott, 2019). This is particularly important in the context where many organisations are increasingly electing scientists to take on leadership roles (Perry *et al.*, 2017). For example, in Uganda where the study is situated, the Head of State has called for top positions in planning organisations to be reserved for scientists and has consistently pushed academic institutions to focus more on the natural sciences (The East African, 2018; The Independent, 2019; Daily Monitor, 2020; The Observer, 2020). The President believes that the humanities are unable to transform Uganda into a modern economy and has driven the agenda of natural scientists at the helm of government agencies.

Additionally, government agencies are investing heavily in leader development. The Uganda Revenue Authority (URA) earmarked Financial Year 2019/2020 as a year for leadership development, investing as much as USD 300,000 for training its supervisors up from USD 50,000 in the previous year. URA's corporate strategy identifies leadership development as one of its overarching strategies. Similarly, several government agencies, including the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF), the Petroleum Authority of Uganda (PAU), and Uganda National Roads Authority (UNRA) established two-year leadership development programmes in 2019. For such entities associated with the natural sciences, it is important that leader development interventions are guided by approaches that engender leadership effectiveness. This study, therefore, has both academic and practical relevance.

1.4 Purpose of the study

The purpose of this retrospective mixed-methods multi-case comparative case study is to examine the experiences of leadership development among natural scientists in supervisory positions and the relationship between development approaches and perceived leadership effectiveness. The study aims to identify leader development approaches associated with higher levels of leader effectiveness among leaders in natural science settings.

1.5 Research aims and objectives

The study aims to identify leader development approaches associated with higher levels of leader effectiveness among leaders in natural science settings. This is achieved through the following study objectives

Primary objectives

1. To identify the contextual influences on leader development such as attitudes, beliefs, subjective norms, intentions and experiences, unique to natural scientist leaders in Uganda.

2. To identify the leader development approaches considered most effective for natural scientists.
3. To assess the level of exposure to leader development approaches and its relationship to levels of perceived leadership effectiveness among natural scientists.
4. To explore the leader development approaches that are likely to lead to leader effectiveness among natural scientists.
5. To develop a model appropriate for leader development among natural scientists

Secondary objectives

In achieving the above objectives, the study's wide scope also looks at the following antecedental secondary objectives:

- To identify why particular leader development approaches are effective
- To develop a construct and measure of leadership effectiveness
- To compare leader development experiences among natural scientist and non-scientist supervisors

1.6 Research questions

The study uses the following research questions to guide the inquiry:

1. How do the attitudes, beliefs, subjective norms, intentions and experiences of leader development among natural scientists in Uganda differ from those of non-scientist leaders?
2. What leader development approaches are considered more effective than others within the context of natural scientist leadership and why?
3. How does the degree of exposure to particular leader development approaches relate to perceived leadership effectiveness among natural scientists?
4. What leader development approaches and practices are associated with higher leadership effectiveness among natural scientists?
5. What model can explain effective leader development among natural scientists?

1.7 Conceptual framework

Leader development is a function of many interrelated influences on the individual's intrapersonal and interpersonal characteristics as well as contextual influences in the organisation, industry or field (Day *et al.*, 2014). Intrapersonal characteristics that can predict leader development include personality (Mumford, Zaccaro, *et al.*, 2000), self-efficacy and leader efficacy (Hannah *et al.*, 2008), cognitive capabilities (Spencer, McClelland and Spencer, 1992) and learning styles (Kolb, 1984) among others.

Interpersonal characteristics include “social interactions that occur within the leadership process” (Day *et al.*, 2014, p. 68)—for example, social capital and effective working relationships (Bilhuber Galli and Müller-Stewens, 2012). Contextual influences include the organisational culture, climate, economic environment, and how much it encourages the learning of leadership. There are many theories that explain leader development. However, as highlighted in chapter 2, section 2.11, none is sufficient to address the research questions, therefore, requiring that the study uses a conceptual framework as outlined in section 2.11.7. Given the complexity and multiplicity of factors associated with leader development, the conceptual framework guides the study to limit itself to the relationship between participation in leader development practices, perceived leadership effectiveness and the mediating constructs such as attitude, subjective norms, perceived behavioural control, self-efficacy, expert and industry knowledge, leader characteristics and contextual influences.

1.8 Nature of the study

The study employs a pragmatic philosophy combining qualitative and quantitative methods in a mixed-methods, sequential explanatory, multi-case comparative case study (Stake, 2006; Fetters, Curry and Creswell, 2013; Goodrick, 2014; Yin, 2014; Creswell and Plano Clark, 2018). The adoption of post-positivism and constructivism research philosophies was deemed necessary given the study’s aim of developing a framework for leader development (Creswell, 2013). Moreover, since there were no studies previously examining leader development among natural scientists in Uganda, an exploratory approach was considered most suitable (Saunders *et al*., 2016).

This design is chosen to answer the research questions and objectives highlighted above pragmatically. Outside of an experimental or quasi-experimental design, the multi-case case study design enables the comparison of the leader development experiences and approaches among leaders within traditionally natural science biased organisations like MAAIF (with a range of natural scientists) and a traditional generalist/non-technical organisation—URA (Goodrick, 2014; Bartlett and Vavrus, 2016, 2017). Nevertheless, both cases are similar in terms of organisational systems, structures, and culture, given that they are both government agencies. Additionally, the mixed-methods approach enables the triangulation of the findings (Stake, 2006; Mertens and Hesse-Biber, 2012; Yin, 2014; Creswell and Plano Clark, 2018). Moreover, given that little is known about the phenomenon of leader development interventions specifically appropriate and targeted to natural scientists (Perry *et al.*, 2017), qualitative inductive subjectivism is relevant for the qualitative phase of the study (Denzin, 2010; Stentz, Plano Clark and Matkin, 2012). This constructionist lens enables the study to address objectives 1 and 2 of the study. On the other hand, the study’s quantitative phase involves the much more objectivist, deductive approach leveraging quantitative methods to provide the inferential base needed to answer research questions 3 and 4 and its corresponding objectives 3 and 4.

Therefore, this study's ontology lies in a continuum between objectivism and subjectivism, while the epistemological orientation inclines towards post-positivism rather than pure constructivism paradigms. This is manifested in the phased sequential approach to this study. The first phase of the study uses an inductive approach, as little is known about what leaders in natural sciences perceive to be the unique learning needs and leader development approaches that are appropriate to their context (Gifford and Finney, 2011). This enables the development of a theory around what is acceptable, expected and what works in leader development within this context through thematic analysis (Stake, 2006; Creswell, 2012; Fetters, Curry and Creswell, 2013; Yin, 2014). The second part of the study is deductive in approach, building the theory by assessing for inference the relative appropriateness of leader development approaches (Dooley, 2002; Stake, 2006; Avolio, 2007; Stentz, Plano Clark and Matkin, 2012). This is accomplished by examining the prevalence of leader development approaches, the association of exposure to these approaches and the perceived leadership effectiveness among those highly exposed to specific leader development approaches.

The research strategy employed is a case study of two organisations representing two distinct groups—natural scientists and non-scientist leaders. Using a mixed-method design, the study involves semi-structured in-depth interviews and a retrospective cross-sectional survey to ascertain the prevalence of various leader development practices and their attendant levels of exposure as well as self-reported leadership effectiveness. The analysis techniques provide both descriptive and inferential statistics that enable the formulation and advancement of a theory. Semi-structured focus group discussions are also used to triangulate the findings by clarifying the content of some of the survey questionnaire results (Creswell and Plano Clark, 2018). This study's time horizon is cross-sectional, given the limited time and resources to answer the research questions.

Table 1.1 highlights how the study is organised and aligns the research objectives, questions, thematic analysis and research tools.

Table 1.1 Mapping of research objectives, questions and tools

Research Questions	Research Objectives	Related Questions in the Questionnaire	Related themes from Qualitative Data	Related questions in the interview protocol
1. How do the attitudes, beliefs, subjective norms, intentions and experiences of leader development among natural scientists in Uganda differ from those of non-scientist leaders?	1. To identify the contextual influences on leader development such as attitudes, beliefs, subjective norms, intentions and experiences, among natural scientist leaders in Uganda.	• Question 4.1 • Questions 1.1-1.6 • Questions 2.1 • Question 2.2	• Attitudes • Subjective Norms • Perceived Behaviour Control • Intention • Leader development experiences and practices • Contextual influences • Societal expectations • Industry experience • Leader identity • Leader self-efficacy • Leader characteristics • Lifespan experiences • Early childhood experience • Organisational culture and practices	• Questions 1.1—1.3 • Question 1.5 • Question 1.7 • Question 1.8 • Question 1.9 • Question 1.10 • Question 3.2 • Question 3.3 • Question 3.9 • Question 4.0
2. Why are certain leader development approaches considered more effective than others within the context of natural scientist leadership?	2. To assess the leader development approaches considered more effective for natural scientists.	• Question 2.1 • Question 2.2	• Coaching • Mentorship • Feedback • Experiential Learning • E-Learning • Formal Leadership Training • Networking • Self-directed learning • Self-awareness • Industry experience • Leader identity • Leader self-efficacy • Lifespan experiences • Organisational culture and practices • Contextual influences	• Question 1.4 • Question 1.5 • Question 1.6 • Question 2.1—2.2 • Questions 3.1—3.9 • Question 4.0 • Questions 4.1—4.15

Table 1.1 Continued. Mapping of research objectives, questions and tools as guided by the conceptual framework

Research Questions	Research Objectives	Related Questions in the Questionnaire	Related themes from Qualitative Data	Related questions in the interview protocol
3. How does the degree of exposure to particular leader development approaches affect perceived leadership effectiveness among natural scientists?	3. To assess the level of exposure to leader development approaches and its relationship with levels of perceived leadership effectiveness among natural scientists.	Question 3.1 Question 2.1	• Coaching • Mentorship • Feedback • Experiential Learning • E-Learning • Formal Leadership Training • Networking • Leadership roles • Self-directed learning • Self-awareness • Leader development experiences and practices • Contextual influences • Leadership effectiveness	• Questions 2.1—2.2 • Question 4.0 • Questions 4.1—4.15
4. What leader development approaches and practices are associated with higher leadership effectiveness?	4. To explore leader development approaches that are likely to lead to leader effectiveness among natural scientists.	Questions 1.1-1.6 Question 3.1 Question 2.1 Question 2.2 Question 4.1	• Coaching • Mentorship • Feedback • Experiential Learning • E-Learning • Formal Leadership Training • Networking • Leadership roles • Self-directed learning • Self-awareness • Leader development experiences and practices • Contextual influences • Leadership effectiveness • Leader characteristics	• Question 1.2 • Question 2.2 • Question 3.3—3.6 • Question 3.8 • Question 4.0
5. What model can explain effective leader development among natural scientists?	5. To develop a model appropriate for leader development among natural scientists	Questions 1.1-1.6 Question 3.1 Question 2.1 Question 2.2 Question 4.1	• Contextual influences • Leader characteristics • Leader development approaches	• Question 1.2 • Question 2.2 • Question 3.3—3.6 • Question 3.8 • Question 4.0

1.9 Study limitations

The study uses a small sample of scientists for pragmatic reasons, purposively selecting participants in order to represent the various strands of natural science sub-disciplines. Whereas this provides a wide range of perspectives that previous studies have missed, the limitation is that only a few sub-discipline representatives are included in the study. Even though participant experiences span scientific disciplines, gender and organisational context, it is plausible that their cumulative perspective does not encompass the breadth of leader development experiences for most natural scientists. The lack of random sample selection exposes the study to bias and limits generalisability. Nonetheless, the limitations of a nonrepresentative sample are minimised by selecting natural scientists from multiple agencies linked to MAAIF. Additionally, respondent selection continues throughout the data collection period until a degree of saturation with the themes arising out of the interviews is achieved (Corbin and Strauss, 2008).

Furthermore, the study is limited in that it looks at the perspective of only leaders holding a supervisory position at the time of the interview, thereby eliminating individuals providing leadership in the organisations, even though they had no direct reports. By narrowly defining leadership in terms of positions, non-supervising leaders' perspective is left out. This may not represent the views or experiences of young scientists at the start of the leadership pipeline, who indeed provide leadership or who find themselves in leadership roles as a result of the COVID-19 crisis (Perry, Mobley and Brubaker, 2017; Bartsch *et al.*, 2020; Dirani *et al.*, 2020). Future studies should expand the sample size by including a breadth of senior and junior scientists. The study is retrospective in nature and is potentially exposed to recall bias, as many of the participants recall lifespan experiences and leader development activities from decades earlier. Moreover, leadership effectiveness was measured only as perceived leadership effectiveness. Additionally, the study is conducted in a developing country setting—Uganda. Whereas this brings a fresh perspective to extant research on leadership, which is often conducted in developed country contexts and cultures, the findings are not generalisable.

1.10 Significance of the study

Academically, this study adds to the body of knowledge by expanding on the Theory of Expert Leadership (Goodall, 2016), and the application of the Theory of Planned Behaviour (Ajzen, 1991). It also examines the relevance of various leader development approaches in natural science fields within an African context, thereby expanding our understanding of leader development in specialised contexts. From a theoretical perspective, the study shows how social identity among expert leaders has a powerful impact on leader development, as it affects both leader characteristics (such as attitude and perceived behavioural control) and developmental opportunities to perform the actual behaviour of participation in leader development. The findings further confirm the applicability of Ajzen's (1991) theory of planned behaviour and extend the theory by proposing the addition of context and leader characteristics as concepts that intermediate the adoption of a behaviour (in this case participation in leader development). Furthermore, the study findings propose that, in a context where social and subjective norms are strongly held, social identity might have a more powerful influence on leader development compared to leader learning efficacy (Avolio and Hannah, 2008; Hannah *et al.*, 2008; Lester *et al.*, 2011). The study findings also suggest that leadership conceptualisation, leader-identity, self-efficacy, structural limitations, and subjective norms, meaningfully attenuate the appetite for leader development activities. The emerging theoretical and conceptual framework is presented as a useful tool that future research can utilise to comprehensively examine the relationships between specific leader development activities and leadership effectiveness.

From a practice perspective, this study's unique contribution is that it recommends a context-appropriate and potentially potent process through which a wide range of natural sciences leaders can be developed. The study proposes a conceptual framework that identifies contextual influences on leader development and outlines relevant and effective leader development approaches. The study outlines what educational architects and policy elites charged with educational responsibility within the natural sciences can do to close critical leadership gaps at various levels of the organisation. It makes recommendations to different stakeholders (including academic institutions) to better prepare natural scientists for leadership roles in organisations. The study enables organisations employing a wide range of scientists to develop leader development policies that work by providing a blueprint for nurturing effective leaders in technical fields as compared to non-technical fields. Additionally, the study proposes a survey tool that organisations can use to evaluate the attitudes, beliefs, subjective norms, perceived behavioural control, and leader development practices among their natural scientist leaders as well as assess their concomitant leadership gaps, thereby providing crucial insights to guide training programmes design.

1.11 Definition of key terms

The thesis has operational definitions for some central terms used in the study as outlined below.

1.11.1 Leadership

The complex nature of the leadership phenomenon has made it difficult to narrow it down to a single definition (Barker, 1997; Bennis, 2007; Harris, Bruce and Jones, 2011). For purposes of this study, leadership refers to the sum total of an individual or teams capability to influence others in a social process that enables the group to clarify and achieve their shared goals (Van Vugt, Hogan and Kaiser, 2008; Day *et al.*, 2014). It may include the use of formal positional authority and power but mostly leverages social power, relationships, individual characteristics and qualities to inspire a group towards shared aspirations (Yukl, 2010; Kouzes and Posner, 2012; DeRue and Myers, 2014).

1.11.2 Leader development and leadership development

The literature frequently interchanges leader development with leadership development (Dalakoura, 2010; Day *et al.*, 2014). Day (2000, p. 581) identified "conceptual confusion" in distinguishing leader from leadership development. He separates the former as a practice to enhance human capital, and the latter as one to enhance social capital within an organisation. This study defines leader development as the approach by which an individual, novice or expert, acquires skills and competences requisite for success in supervisory positions (Mumford, Campion and Morgeson, 2007; Day and Dragoni, 2015; Liu *et al.*, 2020). This includes all manner of practices and experiences one engages in, whether formally or informally throughout their development journey in order to enhance their capability to lead and influence others (Liu *et al.*, 2020).

1.11.3 Approaches

'Approaches' refers to practices, experiences, activities and strategies that organisations or individuals deploy purportedly to enable individuals to learn leadership skills effectively. These undertakings might be deliberately structured or haphazard. They may include activities, policies, norms, leadership conceptualisations, leadership compact, and the process of clarifying attributes desired in leaders—the target of the development itself (Kaagan, 1998; Mumford, Marks, *et al.*, 2000; Liu *et al.*, 2020).

1.11.4 Leadership effectiveness

Madanchian *et al.* (2017, p. 1050) explain that leadership effectiveness "is the ability of the leader to effectively influence followers and other organisational stakeholders to complete the goals of the organisation." The construct relates to the cumulative potency of a leader's knowledge, skills, and capabilities that imbues such influence.

1.12 Thesis outline

This thesis is laid out through six chapters as follows:

1. **Introduction**. Chapter one introduces the thesis by stating the problem, defining the research questions, explaining the topic's importance, and briefly outlining the research approach and methods adopted. The chapter also highlights the study limitations and contribution made.

2. **Literature review**. Chapter two expounds on the background to the problem, research gaps, and provides an extensive appraisal of existing research, setting the topic in the literature. The chapter delineates key issues in leadership development especially among natural scientists, leadership conceptualisation and its impact on leader development, discusses relevant theories of leadership, leader and leadership development and concludes with a synthesis of constructs into a conceptual framework that guides the boundaries of this study.
3. **Methodology**. Chapter three provides a detailed description of the researcher's philosophical stance, the methods used, why they were adopted, and how they were applied. A theoretical basis for why the methods were chosen is also provided. The chapter concludes with the ethical considerations for this study.
4. **Results**. Chapter four reports the results using the mapping of the research objectives and research questions and the themes emerging from the data. It also presents the synthesised findings from both the qualitative and quantitative data along the conceptual framework themes. Throughout the presentation of results, the findings from the natural scientists are compared with the findings from the non-scientists.
5. **Discussion**. Chapter five includes the analysis, synthesis and interpretation of the results and a discussion on the implications of the emerging theory. The chapter illuminates the deductions made from data and presents the emerging model and findings and how they relate to existing research.
6. **Conclusions and recommendations**. The final chapter concludes the study giving prominence to the results, their significance and contribution. It also highlights how the research questions, aims and objectives are fulfilled and makes recommendations for practice, and suggestions for future research.

1.13 Chapter summary

This chapter outlined the background to the study, its rationale and stated the research problem—making a case for examining the leader development experiences of natural science leaders in a developing country setting with the aim of identifying approaches that engender leadership effectiveness. It clarified the research aims, objectives and questions and briefly discussed the study's methods. Chapter two that follows goes in-depth to review the literature on leader development, culminating in presenting the theoretical and conceptual framework that provides research boundaries for this study.

CHAPTER TWO — LITERATURE REVIEW

2.1 Introduction

This mixed-methods comparative study aimed to examine the leader development experiences of technical experts holding supervisory positions in government agencies and organisations associated with the natural sciences in Uganda. The study aimed to identify leader development approaches that are associated with leadership effectiveness within natural science settings. The central question of the study was: *In the context of expert fields such as natural sciences, what is the relationship between leader development approaches and perceived leadership effectiveness and, therefore, what leader development approaches are appropriate for natural scientists?*

The objective of this chapter was to establish what the literature suggests has already been accomplished in understanding how leaders develop in general and in the context of natural sciences or similar specialist fields. It looked at studies of an empirical nature that provided insight into the link between leader development practices and leadership effectiveness. It also critically examined the methods deployed in the foregoing studies and any gaps in the literature. This pivoted the study's theoretical and conceptual framework and refining of the research questions. The study was framed using the theory of expert leadership given its centrality to leadership development among experts. Nonetheless, to extensively understand and contribute to theories of leadership learning, the theory of expert leadership was integrated with other theories of learning as secondary explanations of antecedents of effective expert leadership.

Whereas existing literature is awash with theories and models on leadership and related concepts, this review concerned itself with the aspects of leader and leadership development, how leaders learn and how leadership effectiveness can be measured. Many approaches to leader development and learning, in general, have been suggested in the literature. This review focuses on the key concepts that frequently surface in the literature as relevant practices in nurturing leadership capability amongst expert or specialist leaders such as those responsible for performance in the natural science fields.

There is considerable research in the area of leader development and leadership in technical fields such as natural sciences. This chapter examines the literature and the gaps to which this study contributes. Some scholars have argued that leadership in technical fields has unique characteristics due to its distinctive contexts (Edmonstone and Western, 2002; Winter Institute, 2007; Edmonstone, 2011; Goodall and Carmichael, 2018). For example, in discussing leadership development within surgery, Barnes and Rennie (2021) have argued that hierarchical and authoritarian leadership styles are common in this specialist field, and that leadership training targets mostly those in senior roles, making some to overestimate their leadership capabilities. For purposes of this study, leaders in technical fields are those leaders who supervise scientists, engineers, technicians and other professional personnel in organisations within the natural sciences.

2.2 Search strategy

Databases such as EBSCO, Google Scholar and SCOPUS which are known to have comprehensive sources in the social sciences were searched. Other databases included the Cochrane, ScienceDirect and PubMed in order to identify additional literature from the medical and natural sciences fields. Search terms included Leadership, Leader* Development, Learning, Learning Leadership with operator AND alongside terms such as Technical personnel, Scientist*, Natural Science*, Leader Effectiveness, health professionals, engineer*, agricultur* AND Africa, Uganda. Additional literature was obtained through snowballing.

No limitations were put on time of publication. Studies were included if they were relevant to the study objectives, were published in peer-reviewed journals, or they had a clear methodology that was sound. Studies published in the top journals on leadership as ranked by SCIMAGO were prioritised. Other sources such as books from leading scholars in leadership and grey literature from the case study organisations were included for context.

2.3 Leadership—definition and theories

Harris, Bruce and Jones (2011) brought to light the extensive amount of literature on the subject of leadership both from the academic and contemporary culture standpoints. From a leadership education perspective, they found that unlike academic literature that was broader in its conceptualisation of leadership beyond the individual and included theoretical perspectives, leadership was largely defined by a personal characteristic that can be developed in a do-it-yourself fashion by popular culture literature.

Despite the widespread extant research on the subject, leadership "remains an elusive construct." (Connell, Cross and Parry, 2002, p. 139). This makes leadership problematic to define as it remains a hotly debated topic in the literature (Connell, Cross and Parry, 2002). But how can one develop what one does not fully understand? Indeed, as Barker (1997) argued in an aptly titled paper, "How can we train leaders if we do not know what leadership is?" (Barker, 1997, p. 343). Baker contends that existing literature has unhelpfully defined leadership and how it's developed mostly from the perspective of traits, skills, knowledge, and behaviours and the nature of leadership as a linear goal-focused action where the leader gets things done through others in a process devoid of social interaction, conflict or follower engagement (Barker, 1997; Conger and Ready, 2004; Dalakoura, 2010; Day *et al.*, 2014). Similarly, Rost (1993) argues that this is leadership conceptualised as 'good management' and like others who argue that leadership is more than the intrapersonal and therefore extends to the interpersonal, socially driven, context dependent, process oriented phenomenon, the narrow fascination for Hollywood-like charismatic all powerful heroes as leaders, has led to leadership training programmes that are insufficient in nurturing leaders capable of solving modern complex pressing problems that require the navigation of complex relationships, interests and contexts (Conger, 1993; Barker, 1997; Day, 2000; Day *et al.*, 2014). Clearly, how leadership is defined and conceptualised is important in determining how it is measured or developed, but even more importantly, the theory underpinning such definition frames the efficacy of leader and leadership development (Day, 2000; Oyinlade, 2006; Avolio, Avey and Quisenberry, 2010; Day and Dragoni, 2015).

2.3.1 Leadership defined

The complex nature of the leadership phenomenon, has made it difficult to narrow it down to a single definition (Barker, 1997; Bennis, 2007; Harris, Bruce and Jones, 2011). This challenge (first captured by Stogdill (1974) who observed that leadership definitions abound in equal measure to the number of people attempting to define the phenomenon), has been made even more complex by researchers who look at the proverbial elephant only from one perspective rather than an integrative whole (Winston and Patterson, 2006; Bass and Bass, 2008). However, as Ospina and Schall (2001) argue, the philosophical stance and lens through which the definition is made matters.

In the early years, leadership was conceptualised as positional in nature and the role of the leader being to define the task and exert influence on the follower through reinforcement contingencies that modify the behaviour of subordinates to accomplish the task (Manz and Sims, 1980). This view of leadership, fashionably packaged as the 'carrot and stick' philosophy, continues to permeate modern management practices (Thibault Landry *et al.*, 2017). Moreover, this perspective looks at leadership as a function of getting results and coordinating individuals towards a specific goal (Yukl, 2008; Bennis, 2009; Vogelgesang and Lester, 2009). For example, looking at the evolution of leadership, Van Vugt, Hogan and Kaiser (2008) depict leadership as "influencing individuals to contribute to group goals and coordinating the pursuit of those goals" (Van Vugt, Hogan and Kaiser, 2008, pp. 182–183). Yukl (2010) expands on this idea of working towards specific goals through a process of influence rather than coercion by adding that such goals are shared by both the leader and follower in what Kouzes and Posner (2012) called "mobilising others to want to struggle for shared aspirations" (Kouzes and Posner, 2012, p. 30). Agreeing to this relationship dimension of leadership, Yukl (2010) surmised that, "Leadership is the process of influencing others to understand and agree about what needs to be done and how to do it, and the process of facilitating individual and collective efforts to accomplish shared objectives" (Yukl, 2010, p. 8).

This view of leadership being a relational, social construct was not ubiquitous in the 1980s where leadership was viewed largely from the great man theory perspective (Ospina and Schall, 2001). Where a person not in a position of authority demonstrates ability to behave in alignment with expectations, (in essence, self-management), that was construed not as leadership but as a "substitute for leadership" (Manz and Sims, 1980, p. 361). Followers were deemed to be non-leaders and intrapersonal skills such as self-influence not understood as leadership. Manz and Sims (1980) argued that organisations could benefit more by developing this self-management skill among employees as it is less expensive compared to having a manager. This traditional view of leadership that characterised the 1980s was questioned by Bass (1985) who argued for a fresh lens to look at leadership, a form that emphasised the leader's behaviour, values, inspirational qualities and ability to stimulate intellectual engagement of followers to the extent that they could perform beyond what normal leader-follower exchange models expected. In contrast to the traditional perspective on leadership, Bass (1985, p. 9) argued that, "subordinate motivation to work cannot be fully accounted for by any notion of a simple swap of desired material and psychic payments from a superior in exchange for satisfactory services rendered by subordinates." This gave birth to the transformational leadership theories, which then encapsulated leadership inquiries over the next 20 years (Avolio, Waldman and Yammarino, 1991; Bass, 1995; Avolio, Bass and Jung, 1999; Giddens, 2018; Jackson, 2020)

Connell, Cross and Parry (2002), while looking at the perspective of leadership in the 21st century, have posited that leadership goes beyond formal authority, position and power. Connell *et al.* (2002) have said that "Although leadership is frequently equated with power, influence and status, acts of leadership can be observed right across organisational structures" (Connell, Cross and Parry, 2002, p. 139). Indeed, as contemporary leadership guru John C. Maxwell has observed in his best-selling books 'The 360-degree leader' and the '5 levels of leadership', one might have the position but lack the influence while those without formal positions can have extensive power and influence across the organisation (Maxwell, 2005, 2013).

The times and situations have tended to define the kind of leadership skills and competences needed and therefore clouded people's understanding of leadership only in those terms. For example, whereas the command-and-control models worked in the industrial age, globalisation, volatility and complexity led to the shift where organisations see people rather than assets as a competitive advantage, necessitating the need for more collaborative leadership and a focus on the social, interpersonal skills as opposed to human capital skills (Conger, 1993; Day, 2000; Mumford, Campion and Morgeson, 2007). In the post COVID-19 period, scholars have argued that collaborative leadership, exemplified by trust building, team building, humility and empathy, as opposed to coercive means and hierarchical styles, is the 'new normal' for effective leadership (Ahern and Loh, 2020; Binagwaho, 2020; Nsabimana and Jordans, 2020; Stoller, 2020).

However, the idea of leadership as being more than positional but reciprocal and messy with interpersonal conflict, was recognised by Burns as early as the late 70's (Barker, 1997). Burns (1978, p. 425) explains leadership as "the reciprocal process of mobilising, by persons with certain motives and values, various economic, political, and other resources, in a context of competition and conflict, in order to realise goals independently or mutually held by both leaders and followers."

Perhaps taking a relativist paradigm, Connell *et al.* (2002), surmise that, "Although no one perspective is entirely accurate, nor entirely irrelevant, the answer to exceptional leadership remains relatively unclear" (Connell, Cross and Parry, 2002, p. 140). Connell *et al.* (2002) add though, that research shows a redirection from the command-and-control approach to collaborative leadership. For example, DeRue and Myers (2014) have explained leadership with reference to a process involving multiple actors influencing each other to achieve a collective goal. This emphasises a social and mutual nature of the influence, thereby extricating authoritarian leadership styles from leadership. DeRue and Myers (2014) have defined leadership thus: "a social and mutual influence process where multiple actors engage in leading-following interactions in service of accomplishing a collective goal" (DeRue and Myers, 2014, p. 834). In concert with DeRue and Myers, Day (2000) conceptualises leadership as a process that emerges "as people rely on their mutual commitments, trust, and respect to create new meaning that replaces what has been traditionally provided by formal structure, planning, and control" (Day, 2000, p. 606). Day (2000) has observed that such leadership as this is what organisations are pushing to develop and recommends that, "Leadership development needs to evolve to a level of contribution whereby it is considered an investment in the social capital of the organisation, to complement its human and intellectual capital" (Day, 2000, p. 606).

However, others have argued that leadership, especially in consideration of its development, and how leaders occupy roles, cannot be divorced from the leader and the leader's characteristics including personality, skills and abilities, considering a plethora of research that links the leader's innate traits with effectiveness, readiness and learning efficacy (Arvey *et al.*, 2006; Hannah *et al.*, 2008; King, Johnson and Van Vugt, 2009; Harms, Spain and Hannah, 2011; Caldwell and Hayes, 2016; Avolio and Hannah, 2020). For example, Mumford, Campion and Morgeson (2007) have conceptualised leadership in terms of skills, because the 'leader characteristics' approach has had a chequered history, arguing that "Skills represent capabilities that can be developed" and redirecting attention from leader characteristics to "the job of the leader, and the skills it requires" (Mumford, Campion and Morgeson, 2007, pp. 154–155). Providing an evaluation of what is needed more at higher levels of the organisation as compared to the lower levels, Mumford *et al.* (2007) further infer that, "as managers are promoted up through jobs in the organisational hierarchy, the acquisition of Strategic and Business skills will be more critical than the acquisition of Interpersonal and Cognitive skills" (Mumford, Campion and Morgeson, 2007, p. 158).

However, as Avolio and Hannah (2008) contend, the leader's characteristics such as leader self-view, metacognitive abilities, self-efficacy and learning efficacy are predictors of leadership development (see also Hannah *et al.*, 2008). If someone does not believe they can learn leadership skills, they are unlikely to engage in leader development programmes; and given the emphasis by Mumford *et al.* (2007) that leadership skills are cumulatively learned, such a leader may not develop to the levels needed at higher complex levels. As such, the characteristics of the leader matter in the way they lead and how they learn leadership (House and Howell, 1992; Arvey *et al.*, 2006; Vukasović and Bratko, 2015).

It appears therefore that the conceptualisation of leadership and how it is developed is governed by the theory of leadership adopted—something that Bass and Bass (2008) said is more worthwhile than working to narrow down to a specific definition of leadership, since it looks at the aspects of leadership one is interested in. Moreover, in a meta-analytic study of the impact of leadership interventions, Avolio *et al*. (2009) found that positive outcomes were predicated 66% by the intervention, but that such an effect "varied significantly when assessing moderators such as type of leadership theory" (Avolio *et al.*, 2009, p. 764). This underscores the significance of leadership theory in research and practice, as it governs one's understanding of what leadership is, its impact, how it can be measured, and how it can be learned. The next section therefore looks at various theories of leadership and concludes with the theory adopted for this study.

2.3.2 Theories of leadership

The desire to understand and explain leadership has been part of the human psyche for centuries. Concepts of leadership date back thousands of years ago in the ancient Chinese wisdom of philosophers such as Lao Tzu and their Taoism (Low Sui Pheng, 1995). Depicting the non-positional nature of leadership, for example, Lao Tzu said, "A leader is best when people barely know he exists, when his work is done, his aim fulfilled, they will say: we did it ourselves" (Hanges *et al.*, 2016, p. 64). Additionally, he emphasised leading by example rather than force, inspiring and empowering followers and balancing strengths with softness or empathy (Chan, 2015). The theorisation of leadership as a relational, social, goal-focused process is not novel. However, the dominant theories of leadership did not start there. The principal question was whether leaders were born or made, a myth that produced the great man theory but still permeates leadership debates to date (Wai, 2014; Avolio and Hannah, 2020).

2.3.2.1 Great man theory

The great man theories influenced early understanding of leadership. Leadership was largely seen through individual prowess bestowed by naturally endowed attributes. This view, espoused by the great man theory, saw leaders as born rather than made, making it a preserve of the few and something that cannot be developed (Mccleskey, 2014; Avolio and Hannah, 2020).

By looking to leadership in all its complexity beyond coordination, it emerges that intrapersonal qualities have their limits (Day, 2000). Leadership involves inspiring a vision, nurturing and developing others, service and integrative thinking (Bennis, 2007, 2009; Conger and Riggio, 2012; Kouzes and Posner, 2012; Pearse, 2017). Moreover, scholars have argued that the need for leadership escalates as the challenge gets more complex, wicked and demanding of strategic approaches; whereby leaders would then need to demonstrate a far larger tapestry of capabilities that innate traits or cognitive prowess cannot suffice (Conger, 1993; Mumford, Campion and Morgeson, 2007; Maxwell, 2013).

King *et al.* (2009, p. 913) have suggested that "having some unique knowledge or expertise increases the likelihood of an individual emerging as leader and attracting an enthusiastic following." This is supported by the theory of expert leadership and is prevalent in the natural sciences (Goodall and Bäker, 2015). However, McCall and Hollenbeck (2008) have argued that expertise is not a preserve of the technical fields only but also in general leadership. Moreover, expertise is domain specific and one could be an expert physician or seasoned engineer but a novice leader who must put in the hours of leadership practice and concomitant reflection to master leadership skills (Perry *et al.*, 2017). McCall and Hollenbeck (2008) contend that expertise is learned through the intentional intensive effort for a minimum of ten years and that developing such capacity which transcends knowledge and experience requires one to apply personal drive alongside help from others. Leader development should, therefore, be a very structured deliberate practice, within which the individual traits form the foundation on which to cultivate further expertise. Moreover, even traits can be learned. For example, Bass (1990) has advocated for transformational leadership to be the focus of all management training and leadership development efforts, arguing that "leaders at all levels can be trained to be charismatic" (Bass, 1990, p. 27).

The great man theory fails to explain the ineffectiveness of leaders in specific contexts, and the lack of consistency of performance in different contexts, particularly at higher levels of responsibility, means that there would be more to leadership than personal attributes can provide (Hoffman *et al.*, 2011; Ayman and Lauritsen, 2018).

2.3.2.2 Trait and behavioural theories

The failure of the great man theory gave birth to the trait theories, which argued that specific traits and competencies could explain effective leadership and that these could be nurtured. Kouzes and Posner (2012) have reported on a consistent study across decades where they survey thousands of people across cultures to select the top most admired characteristics from leaders. "Honest, forward-looking, competent and inspiring" (Kouzes and Posner, 2012, pp. 34–35), topped each time across different countries.

The trait and behavioural theories have influenced the emergence of specific competencies and qualities of effective leadership. According to Connell *et al*. (2002, p. 140), these include "integrity, confidence, extraversion, determination, resilience, the relentless pursuit of goals, the ability to take risks, inventiveness, conscientiousness, the readiness to face uncertainty, innovativeness, adaptability, knowledge of the market and the ability to learn from adversity." Moreover, Zaccaro, Kemp and Bader (2004) as well as Zaccaro *et al*. (2018) have expanded on this list of attributes beyond personality, to include elements of social skills, cognitive ability, expertise, values and motivation. Bennis (2007, 2009) has argued that of all the leadership competencies, for example technical, interpersonal and conceptual skills, the most important is character, given the havoc that "effective leaders with a perverse agenda" (Bennis, 2007, p. 3) can wreak on followers. Bennis (2007) says that for a leader to be effective, character above all else is essential. This suggestion of the pre-eminence of character is echoed by others who see values, ethics and integrity as an essential components of building trust and that trust enables the leader to build the social capital among their team (Maxwell, 2005, 2013; Kouzes and Posner, 2008, 2012; Bennis, 2009).

However, despite its prevalence in the literature the trait theory does not comprehensively explain the difference in performance under the same leader in different contexts (Hoffman *et al.*, 2011; Mccleskey, 2014; Zaccaro *et al.*, 2018; Gardner *et al.*, 2020). One might ask, as to what happens to these individual traits (innate or nurtured) in situations where the leader's effectiveness has waned. Some literature suggests that a plausible explanation could be that these traits and capabilities wane and therefore, as the experiential learning theory and the cognitive learning perspective purports, need necessity for continuous learning and reflection to hardwire these behaviours (Pollock, Jefferson and Wick, 2015). Nonetheless, this demonstrates how the trait theory ignores the mediating factor of context and the situational nature of leadership (Ayman and Lauritsen, 2018; Zaccaro *et al.*, 2018). Context has been established to impact on how leadership is expressed (Pawar and Eastman, 1997; Oc, 2018; Zaccaro *et* *al.*, 2018). Accordingly, Liu *et al.* (2020) articulates how context not only explains how leaders behave but also how leadership skills develop. They suggest that it is a mediating aspect between individual characteristics, such as learning orientation and leader self-view. This is consistent with what Dweck (1986) and Hayamizu and Weiner (1991) have observed, that low perceptions of ability alongside factors such as perceptions of required effort and difficulty, was negatively associated with learning goal tendency. Liu *et al.* (2020) therefore suggest that, "the experiential processing system incorporates continuous learning from experience, deliberately practicing and strengthening skills learned, and applying them to real leadership contexts, all facilitated through feedback from others… [a] system...bolstered by individual characteristics around learning goal orientation and leader developmental efficacy" (Liu *et al.*, 2020, p. 11).

The dominance of the trait theory in the 20th century and its continued popularity in the early parts of the 21st century, highlight how much the debate on leaders being made or born pertains in the literature, and suggest that the recent consensus is less on born vs made but rather, born then made (Wai, 2014; Avolio and Hannah, 2020). This acknowledges that traits do indeed have a foundational element in determining leadership effectiveness; at the very least by explaining how genetic predispositions and innate abilities such as personality, intelligence, and other cognitive traits may explain differences in leadership capacity or the propensity to learn leadership. For example, studies have found a significant association between leadership (or ability to rise into higher leadership positions) and extraversion, intelligence and other heritable traits (King, Johnson and Van Vugt, 2009; Zaccaro *et al.*, 2018; Liu *et al.*, 2020). However, in what they called "a theoretical study exploring experiential opportunities across the course of life and...the underlying mechanisms that foster leader development," Liu *et al.* (2020, p. 1) recognise the effect of epigenetics in developing leadership skills, but conclude that "not everyone can become a top leader despite effortful time and practice" Liu *et al.* (2020, p. 5). They add that the leader's phenotypic characteristics are given power by the context and environment, whereby environmental changes switch certain leadership genes on and off. Therefore, beyond the attributes of the leader, the understanding of contextual, environmental and developmental experiences becomes critical in our understanding of leader development—making the case for considering situational leadership theories in the current study.

2.3.2.3 Situational and contingency theories

The disdain of the trait based theories resulting from their inability to explain inconsistency in leadership behaviours across contexts led to the emergence of situational and contingency theories (Zaccaro, 2007; Grint, 2011; Yukl, 2011). According to Yukl (2011), contingency theories are those that "describe how aspects of the leadership situation alter a leader's influence on an individual subordinate or a work group" (Yukl, 2011, p. 286).

Fiedler (1964) introduced the theory of contingency, proposing that effectiveness in leadership depends on the situation; consequently, different situations demand different leadership styles between a task-orientation or relationship orientation. Fielder (1964) argued that effective performance depended on the relationships the leader has with the followers and how much the leader can exert influence in a given task (Grint, 2011; Yukl, 2011). Hersey and Blanchard (1974) took this contextual aspect of a leader's behaviour further by expanding from a task to a people orientation. Hersey and Blanchard (1974) argued, that for optimum team performance, the effective leader is one who has a rational understanding of the situation and has evaluated the skill and maturity levels of the follower in aspects of competence and commitment, and thereby applied a befitting leadership style. The higher the subordinate maturity, the lower the directing behaviour should be from the leader. For example, delegation would work well with followers who have proficiency in a task and a high degree of commitment to do it; a situation where directing would be perceived as micromanaging by competent followers, thereby diminishing their performance.

This acknowledgement that a leader being recognised as one, and their eventual performance are contingent on the context and the behaviour expected of the leader in a specific situation, and therefore that leaders have levers for 'situational engineering' in order to be effective, is well established in the extant literature (Grint, 2011; Yukl, 2011; Ayman and Lauritsen, 2018; Zaccaro *et al.*, 2018; Liu *et al.*, 2020). Besides Fiedler, Hersey and Blanchard, other contingency theory protagonists have included House (1971; 1996) with his path-goal theory. The path-goal theory pivots on the expectant theory of motivation to clarify how leaders inspire performance among followers, through managing followers' opinions of possible consequences for different performance. However, there has been criticism of these theories, particularly because of their ambiguity in defining the variables, insufficient focus on the leader's influence on teams and processes, and the lack of guidance on how multiple situational variables co-interact, with some having a potential for bi-directional causality, and that these theories are often too complex and abstract to test, thereby limiting their utility (Bass and Bass, 2008; Yukl, 2011; Thompson and Glasø, 2018). However, some argue that this criticism is unwarranted and have suggested that situational theories have gone beyond the 'intuitively sound' label and have some empirical support (Ayman, Chemers and Fiedler, 1995; Meier, 2016; Ayman and Lauritsen, 2018; Thompson and Glasø, 2018)

Although there has been extensive research to test contingency theories, strong conclusions cannot be reached (Yukl, 2011). Nonetheless, Zaccaro (2007) has concluded that even though the leader's situation has a significant impact on leadership effectiveness, the behavioural variability needed in the leader demonstrating the appropriate skills and attributes most needed to be effective in a situation, is indeed a trait and this can be nurtured and developed. Further, in arguing for a more prominent role for traits beyond the distal attributes such as personality and cognitive abilities, Zaccaro (2007) suggests that contextual factors indeed do influence leadership behaviour but may only remain distal to the leader's performance in comparison to what he calls proximal attributes such as social appraisal skills (Antonakis, Avolio and Sivasubramaniam, 2003; Avolio, 2007; Zaccaro *et al.*, 2018). Day (2000) agrees, and has suggested that in the development of leadership, both the individual and social qualities need to be considered.

2.3.2.4 Transformational leadership theories

As complexity in organisations increases, and flatter structures get adopted, the demand for leadership effectiveness at all levels has escalated (Conger, 1993). Transformational leadership has been touted as a modern style capable of cultivating effectiveness not only in performance but also in leadership assessment and leadership development (Avolio *et al.*, 1999; Bass, 1990). Further, transformational leadership is described as one that can lead to effectiveness across situations and cultures (Bass, 1990; Diaz-Saenz, 2011; Yukl, 2011). Building on Burn's (1978) characterisation of leadership as a continuum of two constructs—transactional and transformational leadership, Bass (1990) has proposed the multifactor theory of leadership which recognizes that the best leaders combine both transactional and transformational aspects (Avolio *et al.*, 1999). Avolio *et al.* (1999) have reported on how Bass conceptualised leadership as featuring six factors, "Charismatic–Inspirational leadership, Intellectual Stimulation, Individualized Consideration, Contingent Reward, Management-by-Exception and Laissez-faire leadership" (Avolio, Bass and Jung, 1999, p. 442). However, the theory has been criticised as inadequate and unclear in its definition of the mechanism through which the leader influences followers or its impact beyond the individual to teams and organisations (Yukl, 1998; Shamir, 2011). Additionally, critics identified overlaps between constructs and insufficient consideration of the weight of contextual and situational factors on effectiveness and the tendency to define effectiveness in terms of behaviour rather than performance outcomes (Yukl, 1998, 2011; Howell and Shamir, 2005; Jackson, 2020). Anderson and Sun (2015, 2017) have argued that despite its popularity, the theory is riddled with grave problems, chief among which, is the conflation between political leadership at community and societal levels that Burns (1978) originally conceptualised it for and managerial leadership in the context of organisations.

This theory has been improved following some criticism, and remains popular—as the most studied and debated idea in leadership (Diaz-Saenz, 2011). The multifactor model and its measurement tool the MLQ, for example, have become a regular way of measuring and developing leadership styles (Avolio, Bass and Jung, 1999; Tejeda, Scandura and Pillai, 2001). Transformational leadership has been linked to great performance because of its ability to inspire people beyond what they are ordinarily capable of (Aldoory and Toth, 2004; Dionne *et al.*, 2004; Diaz-Saenz, 2011). Avolio *et al.* (1999) have confirmed that a litany of research supports that "charismatic/transformational leadership was positively associated with leadership effectiveness and a number of important individual, group and organizational outcomes across many different types of organizations, situations, levels of analyses, and cultures" (Avolio, Bass and Jung, 1999, p. 766). In fact, it has also been applied in a multiplicity of settings including natural sciences such as medicine.

As Bono and Judge (2004, p. 554) as well as Judge and Piccolo (2004) infer, the cogency of transformational leadership is not in question. The style has been associated positively with subordinate attitude and performance. Whereas it was found not to predict leader job performance, Judge and Piccolo (2004) surmise that it "seems to generalize across many situations, including when it is studied in rigorous settings" (Judge and Piccolo, 2004, p. 765). House and Howell (1992) expand the notion of personality and charisma as leadership by distinguishing those who use their personal characteristics to exploitatively seek influence and power for selfish ends as personalised charismatic leaders while those who considerately use personal traits for egalitarian collective good as socialized charismatic leaders.

However, Avolio *et al.* (1999) suggest that training in transformational leadership or at the very least the combining of transactional leadership models with individualised consideration is necessary to provide a foundation for leadership that can provide an impetus for extraordinary results through charismatic inspiration, a focus on emotional needs and intellectual stimulation. They argue that, "Transactional models of leadership simply do not go far enough in building the trust and developing the motivation to achieve the full potential of one's workforce" (Avolio, Bass and Jung, 1999, p. 460).

The consideration of the different theories above has highlighted why an integrative view of leadership is necessary. In its conceptualisation of leadership, as seen in the conceptual framework (see section 2.16) this study therefore adopted an integrative view, where the measurement of leadership effectiveness and the examination of the practices that enhance leadership skills development incorporate the entire skills *strataplex*—individual attributes such as integrity and critical thinking, social skills including emotional intelligence, strategic skills like visioning and problem solving and contextual drivers such as organisational norms, and role specific technical skills needed in the business (Mumford, Campion and Morgeson, 2007). It also leverages the situational leadership theories and transformational leadership theories to include specific behaviours expected of leaders and methods/approaches that extant literature suggests can be used to develop them.

2.4 Leadership effectiveness

Madanchian, Hussein, Noordin, and Taherdoost, (2017, p. 1050) explain that, "Leader effectiveness is the ability of the leader to effectively influence followers and other organizational stakeholders to complete the goals of the organization." Building on Yukl (2008), Madanchian *et al*. (2017) have argued that leader effectiveness and how it is measured will vary from industry to industry and context to context because of the differences in what encompasses follower influence—a platitude of implicit leadership theory (Harrison, 2018). The most common yardstick for leader effectiveness is leader characteristics and actions and his/her influence on the followers and the team (Madanchian *et al.*, 2017). Scholars have based their measures of leader and leadership effectiveness on a variety of beliefs, depending on their definition of leadership (Oyinlade, 2006)—the trait theory focusing on the natural abilities of leaders (Reeves, 2008); the behaviour theory of leadership focusing on the leader's behaviour (Avolio and Bass, 2004; Posner, 2013); the leadership styles of the leader, such as charismatic, transformational, visionary, laissez-faire and transactional leadership and the impact this has on followers' satisfaction and performance (Bass, 1995, 1997; Avolio, Bass and Jung, 1999); the amount and nature of influence the leader has over followers above and beyond formal authority (Katz and Kahn, 1978); the maturity of the relationship that the leader has with their followers (Graen and Uhl-Bien, 1991); and the leadership competences based on observable skills in the leader and what the organisation has set as standards for effectiveness in a particular job (Conger, 1990; Spencer, McClelland and Spencer, 1992; Conger and Ready, 2004).

Hughes, Ginnett and Curphy (2015) argue that given how much most leadership assessment processes are riddled with faults, there is no perfect or best method of measuring leadership effectiveness. Given the uniqueness of technical expert leadership—for example the importance placed on behavioural characteristics and competencies (Graen and Uhl-Bien, 1991; Oyinlade, 2006)—a context-specific measure of leadership effectiveness is necessary for the present study—one that blends the behavioural theories and the competence models. A number of competences identified as critical for effective leadership include a leader's motivating ability, good listening, providing support to followers, demonstrating knowledge of the organization and role, having good technical knowledge, inspiring a compelling vision, good interpersonal skills, conflict resolution, setting direction for others, good communication skills, strategic thinking and strategic oversight, ability to influence across functions/departments, ability to mentor and develop followers and an appreciation of diversity (Spencer, McClelland and Spencer, 1992; Conger, 1993; Conger and Benjamin, 1999; Conger and Ready, 2004; Kotter, 2007). These skills are relevant for leaders across a multiplicity of industries, cultures and industries (Mumford, Campion and Morgeson, 2007; Kouzes and Posner, 2012; Mumford *et al.*, 2017). For example, Kouzes and Posner (2012) have submitted that integrity and honesty are essential qualities that followers demand from their leaders and that this cuts across cultures and industries and has remained a stable phenomenon over their decades research, even when authentic honest leadership is becoming rare (Bennis, 2007).

However, some scholars have argued that there are some unique leadership skills that are needed in the natural science context. Parker and Hackett (2012) highlight the importance of emotional intelligence as a critical skill in preparing for and managing the "intellectual and emotional challenges born of criticism, resistance, and doubt—the organized scepticism—that characterize the trained scientific response to novel ideas" (Parker and Hackett, 2012, p. 22). The authors also accentuate the need for self-awareness and communication skills when leading scientific groups and movements as means for navigating what they call 'perils of growth.' They also suggest that "interpersonal trust is foundational for the functioning of science…and critical for success," (Parker and Hackett, 2012, p. 24), and that maintaining control in a setting that often has hot moments is essential for collaboration in science (Hackett and Parker, 2011). Moreover, collaboration, creativity and managing conflict have been common features of scientific groups and literature suggests that short bursts of well managed conflicts lead to scientific innovation (Hackett and Parker, 2011; Parker and Corte, 2017).

Additionally, the U.S. National Research Council for science, engineering and medicine has identified a number of critical skills relevant for natural scientists' teams to succeed. These include nurturing a shared understanding of team goals and individual roles, and team leadership with ability to manage conflicts (National Research Council, 2015, pp. 8–10). The authors observe that, "Currently, most leaders of science teams and larger groups are appointed to their positions based solely on scientific expertise and lack formal leadership training…[yet]… effective leadership styles and behaviours can be acquired" (National Research Council, 2015, p. 9). Some of the leadership skills the authors recommend for improving the performance and effectiveness of scientist teams include, pre-emptive approaches to conflict management and mitigation, building trust and cohesion, developing others and enabling the team to build team efficacy, balancing directive and collaborative, participative leadership styles, setting direction and inspiring a vision and building commitment, and attending to socioemotional needs of the team (National Research Council, 2015, pp. 125–147). Furthermore, in a randomised intervention study to evaluate the effect of leader training on outcomes in a medical setting, Ten Have *et al*. (2013) found that leadership behaviours are essential, and that decision-making, communication, and teamwork could be effectively improved through scenarios involving "conflicting situations and workplace-based feedback" (Ten Have, Nap and Tulleken, 2013, p. 1806).

Therefore, building on these attributes, the dimensions of leadership effectiveness considered for the current study are outlined in the section below and are included in the conceptual framework alongside the various elements of leader development approaches that were expected to engender the growth of these characteristics.

2.4.1 Ethics, integrity and interpersonal relations

High integrity, accountable and people oriented leaders have been found to be essential in advancing agricultural development in Africa (Nsabimana and Jordans, 2020). Kouzes and Posner (2012) argue that honesty is the principal quality people need in leaders and Bennis (2007) suggests this is critical in solving today's complex problems. Moreover, ethics and integrity is critical in science not only in research but also practice and policy as has been recently observed during the management of COVID-19 (Smit, 2013; Häyry, 2021). Additionally, moral maturity and self-awareness has been associated with effective leadership and similarly, leadership based on personal attributes such as ethics, values, authenticity, and credibility are particularly important (Toor and Ofori, 2008; Salter *et al.*, 2013; Caldwell and Hayes, 2016; Dopson *et al.*, 2016).

On interpersonal relations, the leader must take their team leadership role seriously and work to build a high performing team through strengthening of team structure and dynamics. This may require improving interpersonal communications, building strong relationships, managing conflict and building trust. It requires mining for and addressing conflict pre-emptively, building consensus, managing fault lines within the team and developing an inclusive environment built on psychological safety where every team member feels valued, respected and their contribution welcome (Salas, Sims and Burke, 2005; Burke *et al.*, 2006; Gray, 2008; Bezrukova *et al.*, 2009, 2012; Stokols, 2014; Khosravi, Rezvani and Ashkanasy, 2020; Rice *et al.*, 2020)

2.4.2 Strategic thinking and communications

Giber and Friedman (2006) contend that strategic thinking is essential for leadership given the increasing complexity of modern society and argue that leaders must accelerate the development of this skill so as to tap into their facilitative and teaching role to spur innovation. This skill is essential in providing direction and aligning current activities with future goals. It enables the leveraging of the leader's technical scientific credentials and competences to make meaning for the junior scientists. Moreover, existing literature emphasises the importance of strategic thinking and critical thinking skills as one rises higher in leadership or gets responsibility dealing with more complex problems (Mumford, Zaccaro, *et al.*, 2000; Mumford, Campion and Morgeson, 2007; Drath *et al.*, 2008; Gray, 2008; Mumford *et al.*, 2017).

On communications skills among natural scientists, Ten Have *et al.* (2013) observed that collaborative communication and improved communication skills led to improved leadership effectiveness and performance of intensive care teams. Literature suggests that due to the interdisciplinary nature of science teams, communication skills are essential for scientific performance (Salas, Cooke and Rosen, 2008; Salas and Lacerenza, 2013; Stokols, 2014; Lacerenza *et al*., 2017). Leaders of natural science teams are often required to listen—clarifying for the team, to speak—inspiring a compelling vision and to write—as way of communicating vision, fostering collaboration and improving performance. This requires competences such as active listening, oral and written, assertive engagement (Fiore, 2008; Gebbie *et al.*, 2008; Ten Have, Nap and Tulleken, 2013; Stokols, 2014).

2.4.3 Emotional intelligence and servant leadership

Mintz and Stoller (2014) observe that the nature of health organisations and how physicians develop largely emphasises the physician as a lone leader, compounding the individual characteristics common to such scientists—self-directed, confident and independent—making collaboration with others an even greater challenge. They further argue that to make the shift, physician leaders need strong emotional intelligence. "Emotional intelligence (EI) is a critical health care leadership competency… [which]... has been advocated as a key competency in all clinical settings—from the boardroom and chairperson's office to the ward and bedside" (Mintz and Stoller, 2014, p. 21). In a study of National Health Service (NHS) managers, Parker and Sorensen (2008) found that emotional intelligence was statistically linked to exhibiting transformational leadership styles. Emotional intelligence enables the leader to attend to socioemotional needs of the science team. Daher (2015) observes that much like culture intelligence, which requires the adaptation to others beliefs, values, norms and cultures in order to be effective, emotional intelligence is essential for individual and team performance. Khosravi *et al*. (2020) found that emotional intelligence is enhances performance in large scale projects. They define the construct as, "the ability to perceive, to assimilate, to understand, and to regulate emotions in self and others" (Khosravi, Rezvani and Ashkanasy, 2020, p. 37).

This requires leaders to embrace a balanced situational style that is contingent in nature, choosing to direct, coach, delegate and support in alignment with the situational demands and team needs. This competence requires the leader to put aside their egocentric and individual needs and with humility, demonstrate a servant heart by putting the collective team goals ahead of their own. Emotional intelligence also requires the leader to stay calm in difficult times, act with a clear purpose, self-manage and self-regulate in order to avoid tuning emotive discussions into conflicts (Goleman, 1995; Burke *et al.*, 2006; Mintz and Stoller, 2014; Daher, 2015; Allen *et al.*, 2016; Goodall and Stoller, 2017; Khosravi, Rezvani and Ashkanasy, 2020).

2.4.4 Team leadership and role ownership

This competence reflects the leader's ability to empower the team and engineer shared leadership. It also includes the responsibility to nurture and develop others, building team efficacy and capacity, for example, through coaching and training and preparing them to take on cumulatively more responsibility over time. It highlights the leader's role in recruiting diverse high capacity team members in ways that align to the needs of the project/organisation, putting them in the right roles and assigning them tasks commensurate with their skills and capabilities (Hersey and Blanchard, 1974; Salas, Sims and Burke, 2005; Kozlowski and Ilgen, 2006; Salas, Cooke and Rosen, 2008; Kozlowski *et al*., 2009; Tannenbaum *et al*., 2012; Mccleskey, 2014; Goodall and Stoller, 2017).

Role ownership refers to the leader's readiness to accept accountability for followers' performance. It requires the soft-skill of accepting personal responsibility for team failures which motivates the leader to reflect on the value of collaboration and an interdisciplinary approach to solving complex problems facing society. It also requires self-efficacy with the leader being convinced that doing so will produce positive results. It requires the leader to fully appreciate their role and that of others in order to avoid role-conflict (Ashforth and Mael, 1989; Kouzes and Posner, 2008, 2012; Vogelgesang and Lester, 2009; Stokols, 2014; Vogel *et al*., 2014, 2020)

2.4.5 Problem solving and decision making

The essence of engineering, medicine and many natural science teams is to solve problems and innovate (Sapienza, 2007; Colcleugh, 2013; Perry *et al.*, 2017). This process requires leaders to address challenges, assign tasks effectively in intragroup interdependencies as well as being aware of one's own biases against the backdrop of diverse, interdisciplinary teams. The leader therefore must consider many options before deciding on a course of action, encourage divergent opinions and demonstrate capability to recognise when their approach to problem-solving is counterproductive and needs changing (Hall, 2004, 2005; Hall *et al.*, 2008, 2012; Borrego *et al.*, 2013; Lattuca, Knight and Bergom, 2013; Stokols, 2014; Vessey *et al.*, 2014; Perry, Mobley and Brubaker, 2017).

Jackson *et al*. (1995) intimate that diversity affects influencing patterns, making it more challenging for decision-making in diverse interdisciplinary teams—common in the natural sciences. The leader is therefore required to balance both directive and participatory leadership styles. They are also expected to consider multiple data sources before a decision is made and welcome critical engagement and sometimes opposing points of view so that the best course of action emerges (Wood and Bandura, 1989; Jackson, May and Whitney, 1995; Hackett, 2005; Sapienza, 2007; Hackett and Parker, 2011; National Research Council, 2015).

2.4.6 Innovation, creativity, visioning

Vessey *et al.* (2014, p. 672) observed that "Eminent scientists represent a population of leaders of highly creative individuals in a field that values the production of innovative ideas and products as a marker of performance." Innovation has been identified as a critical aspect of scientific endeavour and that leaders of the 21st century need it for organisational success. Leaders ought to be creative and demonstrate the ability to create an environment where highly emotive hot spots and hot moments that are seemingly disruptive as used to build trust and encourage innovation. Promoting divergent views, taking risks, and challenging established methods is a competence required of leaders in the natural sciences (Hackett, 2005; Gray, 2008; Edmonstone, 2011; Borrego *et al.*, 2013; Colcleugh, 2013; Alexander and Van Knippenberg, 2014; Vogel *et al.*, 2014; Perry *et al.*, 2017; Hughes *et al.*, 2018; Arensberg, D'Andrea and Khan, 2019; Miles and Scott, 2019; Lobdell *et al.*, 2020).

For this study, the various competences above have been synthesised into the following dimensions as indicated in the conceptual framework and in the study survey questionnaire (see Appendix 4): Role Ownership, Emotional Intelligence, Servant Leadership, Strategic Thinking, Ethics and Accountability, Performance Management, Decision making and Problem Solving, Team Leadership, Communications Skills, and Innovation and Creativity.

2.5 Learning theory and leadership

Leadership, like any other skill or behaviour, is learnable. Leader development is therefore a learning affair (Brown and Posner, 2001; Bennis, 2009; Kouzes and Posner, 2012). Moreover, St Clair (2020) describes learning and leadership as mutually supportive. Leader development can, therefore benefit from decades of research and the theory of learning. To explore how learning connects with leadership, Brown and Posner (2001) studied how people learn and the association this has to how they lead. They conclude that "applying adult learning principles and creating conditions that foster transformational learning are essential in the design and delivery of leadership development efforts" (Brown and Posner, 2001, p. 279). The authors add that, "majority of leadership skills are learned from naturally occurring experiences in the work place. Being able to access and apply principles of adult learning and foster transformational learning would help aspiring leaders, those wanting to strengthen their leadership, and those concerned with the development of leadership, to accelerate and leverage leadership learning" (Brown and Posner, 2001, pp. 279–280).

Mezirow (1994, 1997, 2000, 2003) have described learning as a process of making meaning and reasoning that goes beyond the acquisition of knowledge but the exploration of ideas, questioning of beliefs, values, feelings and assumptions through reflection and engaging with an experience to the extent of being transformed in behaviour. This conceptualisation of learning as transformative in nature, involves reflection, and engages with the cognitive critical thinking domain as well as the environment in an experiential way. It therefore aligns with the seminal work on education and experience by one considered the pre-eminent philosopher in education, Dewey (1938), as well as Bandura's (1986) social learning theory and Kolb's (1984) experiential learning theory (see also Kolb and Kolb, 2009a, 2009b; Kolb, 2014). These seminal works contend that one's experience and the environment condition and determine their behaviour (Dewey, 1938; Kolb, 1984). However, some proponents of self-management have suggested that external consequences or influences alone do not explain the entirety of how people behave (Manz and Sims, 1980).

Borrowing from social learning theory, and looking at how individuals interact with the environment in predicting behaviour—hence learning, Manz and Sims (1980) contend that self-regulatory behaviour in concert with the environmental stimulus together account for an individual's behaviour. "Social learning theory proposes that an integration of cognitive and environmental determinants yields a more adequate explanation of human behaviour than does focus strictly environmental factors," asserted Manz and Sims (1980, p. 363). This is perhaps because Manz and Sims (1980) conceptualised experience and the environment only in terms of external factors, eliminating mental models of experience and environment. In contrast, Dewey (1938) postulated that the environment, "is whatever conditions interact with personal needs, desires, purposes, and capacities to create the experience which is had" (Dewey, 1938, p. 17). To Dewey, people are always learning from their experiences, consciously or not. Experiences of the learner are moderated by previous experiences, the reflections they have had in between those experiences and the prior judgments made about them in an attempt to make sense of the observations and what they signify.

The transformational learning theory has been hailed as novel and particularly relevant in leadership development because it builds on the seminal but sometimes limiting adult learning theories of the past (Brown and Posner, 2001). Mezirow (2003, p. 58) explains transformative learning thus: "learning that transforms problematic frames of reference—sets of fixed assumptions and expectations (habits of mind, meaning perspectives, mindsets)—to make them more inclusive, discriminating, open, reflective, and emotionally able to change." Mezirow (2003) adds that these emerging thoughts would then be more justified in guiding action. In this definition lies a compelling case for transformative learning as a means of developing leadership skills given that leadership as a phenomenon is highly social, relational and situational. The leader as a learner needs, through some form of deliberate practice, a constant reflection on their decisions, choices and behaviour not only to gain a deeper understanding of self but also the impact their attitudes and actions have on others (Conger and Toegel, 2002; DeRue and Wellman, 2009; Fredericks, 2009; Day, 2010; Hughes, Ginnett and Curphy, 2015; Liu *et al.*, 2020). This can be achieved through deliberate practice in formal and informal learning activities (Day, 2010; Liu *et al.*, 2020).

While studying the transformational learning experiences of Asian students in the USA, in colleges of Engineering and Arts and Science, Kumi–Yeboah and James (2014) found that transformative learning accrued from both classroom and noneducational life experience activities. Kumi–Yeboah and James (2014) advocate for universities to design learning programmes that integrate discussion, group projects, and extracurricular activities. Kumi–Yeboah and James (2014) have found that some of the more impactful learning experiences included, “major life changes such as student and faculty support, classroom discussions, new life experiences, and learning a new language” (Kumi–Yeboah and James, 2014, p. 25). Similarly, Hodge *et al.* (2011) found that contrary to popular misconceptions about universities being too theoretical and therefore unable to provide real-world learning experiences akin to what workplaces provide, students engaging in participatory practice-based academic programmes that modern universities provide, indeed experienced transformative learning and were able to critically challenge long held assumptions and learn in ways that practically transforms their world. Hodge *et al.* (2011) surmise that, “learning—whether emanating from the university or the workplace—entails a myriad of characteristics, processes and functions that defy categorisation” (Hodge *et al.*, 2011, p. 181). In reference to Sfard’s (1998) assertion, Hodge *et al.* (2011) agree that misconstruing learning in terms of a single metaphor, such as acquisitional or participational does not serve learning. Sfard (1998) has warned against seeing learning in binary terms as to leaning only to one aspect of learning design and experience. Critically reviewing the good, bad and ugly of each approach, she does not make a case of either metaphor and argues that “too great a devotion to one particular metaphor can lead to theoretical distortions and to undesirable practices” (Sfard, 1998, p. 4).

2.5.1 Action learning and experiential learning

Despite some criticism, Kolb’s (1984) four-stage cyclical model of experiential learning has received widespread acclaim (Kayes, 2002). Many scholars have underscored the value of integrating experiential learning in leader development programmes (Mainemelis, Boyatzis and Kolb, 2002; Edwards *et al.*, 2013; Stead and Elliott, 2013). Armstrong and Mahmud (2008) have suggested that tacit knowledge acquired from work experience is a differentiating factor between good and bad leaders. Experiential learning is relevant in the current study because it is important for leader development to be rooted in the context (Antonakis *et al.*, 2004; Fairhurst, 2009; Mabey, 2013). Moreover, as Yardley, Teunissen and Dornan (2012) posit, experiential learning is central in medical education and other ‘hands-on’ fields—a key feature of technical fields—so as to “allow for consequential learning to be maximized” (Yardley, Teunissen and Dornan, 2012, p. 163). Yardley *et al.* (2012) report increasing research interests among medical educators but this has been limited to technical medical skills and not leadership skills development.

Action learning is the process of gleaning leadership lessons from group-based projects and problem solving through reflection, questioning and learning from day-to-day organisational challenges and opportunities (Revans, 1982, 1991; Conger and Toegel, 2002). According to Leonard and Lang (2010), the value of action-learning to leader development is highly acclaimed. Even then, Conger and Toegel (2002) have found that it is not well implemented and the common formats do not provide wide-ranging experiences or reflective practice necessary to "develop complex knowledge" (Conger and Toegel, 2002, p. 346). Moreover, action-learning is a central aspect of training professionals in the natural sciences such as medicine; although little is known about its application to leadership development (Stanton and Grant, 1999; Collins-Nakai, 2006). However, among the natural sciences, the practice has found some success in some contexts such as agriculture in the U.S. (Raudenbush and Marquardt, 2008).

Dewey (1938) argued that, "an experience is always what it is because of a transaction taking place between an individual and his environment, whether the latter consists of persons with whom he [or she] is talking about some topic or event, the subject talked about being also a part of the situation; or … the book he [or she] is reading (in which his [or her] environing conditions at the time may be England or ancient Greece or an imaginary region); or the materials of an experiment he [or she] is performing" (Dewey, 1938, p. 17). Dewey conceptualised experience as a 'moving force' that has two elements, continuity and interaction. Continuity means that learners will draw lessons from their current experience from the framing of how it builds on what they have already experienced. Interaction on the other hand means that experience is a construction of how individuals interact with their environment. In learning leadership, therefore, one can argue that experience can be construed multi-dimensionally such as while reading a book, listening to a podcast, attending a formal leadership course, meeting a mentor, or interacting with a work problem, or people.

Schon and DeSanctis (1986) suggested that the rigorous reflection required to learn from action and experience can be short-changed by the dysfunctional behaviours of the managers who might in self-preservation not facilitate extensively the emergence of issues that affect performance and that need to be analysed. This lack of 'safe ground' can undermine learning as the leaders limit the nature and extent of inquiry. Schon and DeSanctis (1986) suggested that bringing on board a reflection-in-action professional would help not only to bring the expertise needed to deal with complex issues but also the complex dynamic. In circumstances where leadership learning is expected from projects such as in action learning, it is therefore necessary to consider professional help to provide safe ground. Additionally, according to Liu *et al.* (2020), learning will happen if the process allows the continuous processing of existing experiences through reflection on how new performance is helped by those experiences and experimentation, following which a new model of understanding is developed (Hirst *et al.*, 2004; Kempster, 2006). Feedback from others, as a result of interpersonal interaction is therefore important. Liu *et al.* (2020, p.11) advise that in experiential learning that engenders effective leader behaviour, "individuals need to have concrete developmental experiences, review those experiences, reflect on their performance, and implement the lessons learned... [then]..seek out feedback." Feedback enables the leader to examine their self-view and therefore moderate behaviours in ways that make them more effective. However, this process requires intentionality and not a haphazard approach were leadership can be expected to be automatically gleaned from experience. Intentionality, or 'deliberate practice' as some scholars have put it, involves intentionally putting effort in structured activities and practices aimed to improve a skill or performance from deficiency to mastery level (Day, 2010; Maxwell, 2013; Liu *et al.*, 2020). Liu *et al.* (2020) propose that this process enhances experiential learning due to the added intent with which an individual approaches a task. Therefore, in the exploration of the practices that leaders in natural science field have experienced, the perspectives on experience above were explored as depicted in the semi-structured qualitative interview schedule.

2.5.2 Self-efficacy in leader development

Discussing the how students approach learning, Wilson and Fowler (2005, p. 88) illuminate what Biggs and Tang (2011, pp. 24–27) emphasise—that "students approach learning with either a 'deep…[striving for meaning and understanding]' or 'surface…[instrumental, reproductive and minimalist] approach." This suggests that, at least in part, one needs to be motivated at the level of self to maximise learning. In broader terms, Bandura (1986) postulated this self-motivation as self-efficacy (Bandura, 1986; Wood and Bandura, 1989). Self-efficacy means the "belief in one's capabilities to mobilize the motivation, cognitive resources, and courses of action needed to meet given situational demands," (Mesterova *et al.*, 2015, p. 112).

Kouzes and Posner (2008, p. 2) have argued that "the mastery of the art of leadership comes with the mastery of the self and so developing leadership is a process of developing the self." Bennis (2009) agrees; suggesting that until one gets to know themselves deeply enough to understand their strength and weaknesses, and their true motivations to lead—and by extension to learn leadership—the leader may not succeed. As some scholars have argued (for example, Hannah *et al.*, 2008; Machida and Schaubroeck, 2011), leader development efforts should include ways to increase learning self-efficacy say through encouragement from trusted sources, providing feedback, challenges and support and through self-awareness enhancing activities. Studies done by Caldwell and Hayes (2016) and Jordan, Dasborough, Daus and Ashkanasy (2010), highlight the value of the leader's self-confidence in igniting hope, and inspiring followers.

2.6 Leader and leadership development

Day *et al.* (2014) have observed that the empirical study of leadership development has received limited attention. It is commonplace for the literature to interchange the concept of leader development with leadership development (Dalakoura, 2010; Day *et al.*, 2014). Riggio (2008) and Day *et al*. (2014) have requested for more studies to better understand leader development. Day (2000, p.581) identified "conceptual confusion" in distinguishing leader from leadership development. He separates the former as a practice to enhance human capital, and the latter as one to enhance social capital within an organisation. Nonetheless, in order not to miscount the lessons and best practice on leader development hidden away in the literature that has been labelled as leadership development, this study was less concerned about the conceptual definition as it was about the substance of the practices, activities and approaches that the literature suggests has a bearing on how one can develop capabilities that make them more effective at leading. Moreover, as Bogenschneider (2016) emphasises, an individual's learning philosophy and leadership epistemology impacts on their definition of leadership and consequently on their perspective on leader and leadership development. For example, educators such as Kaagan (1998) define leadership development in terms of teaching, arguing that educators "have a comparative advantage over other professionals when it comes to leadership development" (Kaagan, 1998, p. 74), ostensibly because unlike the consultants despite coming to the process with agility and responsiveness to marketplace needs or the executive whose advantage is experience, the educator supposedly brings expertise to issues of content, curriculum structure and methodology (Kaagan, 1998; Ng and Ruppel, 2016; Mormina and Pinder, 2018).

The current study, therefore, defines leader development as the approach by which an individual, novice or expert, acquires skills and competences requisite for success in supervisory positions (Mumford, Campion and Morgeson, 2007; Day and Dragoni, 2015; Liu *et al.*, 2020). This includes all manner of practices and experiences one engages in, whether formally or informally throughout their development journey, as long as they contribute to the growth of the skills and competences that make one an effective leader in the context where they exert influence in order to achieve desired objectives, particularly where they have a supervisory responsibility (Liu *et al.*, 2020).

2.6.1 Leader development and management development

In concert with DeRue and Myers (2014), Day (2000) acknowledges that leadership bestows a competitive advantage and that developing leaders has become essential for many organisations. However, Day suggests that unlike management development which focuses on learning and applying—mostly through training—specific knowledge, skills and capabilities required to deploy particular solutions to known problems, leadership development is a related concept but that can be defined differently as, “expanding the collective capacity of organizational members to engage effectively in leadership roles and processes” (Day, 2000, p. 582). While management development confines itself to improving performance of those in a formal supervisory position, the vanguards of leadership responsibility demand that leadership development attends to the art of influencing others and engendering a harmonious collaboration between the collective members of a team to achieve the team goals, with or without formal positions and authority. Leadership development, therefore, is about expanding the team’s capacity to interact more meaningfully to solve complex problems, some of which might not have emerged yet (Day, 2000; DeRue and Myers, 2014). However, Maxwell (2013) observes that the first level of leadership is positional, since it provides authority, and that it is the foundation upon which one builds to expand their levels of influence—which accrues from social and relational skills. Nonetheless, Maxwell also acknowledges that anyone can be a leader and one does not need a position first to have influence (Maxwell, 2005). These two seemingly contradictory arguments, illustrate the complex nature of leadership. Some scholars suggest an integrative view that positional responsibility as a fundamental aspect of leadership cannot be ignored since those who hold the position are also expected to be effective in leveraging both their individual skill and social competences to bring forth the social interaction necessary to harness the collective intelligence in a group (Kaagan, 1998; Kouzes and Posner, 2008, 2012; King, Johnson and Van Vugt, 2009). The current study therefore adopted the view of leader development in the broader sense which assesses the experiences and practices of individuals holding supervisory positions (at multiple layers of the organisations) but examines their journey in developing both their intrapersonal and social skills.

2.6.2 Leader development and social skills

To conceptualise leadership as an individual-level skill as Bass’s (1985) transformational leadership theory suggests, means that leader development will only be approached from the lens of nurturing, mostly through training, individual skills (intrapersonal), hoping that leadership capability will be enhanced while ignoring the complex and social nature of leadership and how the leader interacts with their organisational context to influence and serve others towards achieving a goal (Ospina and Schall, 2001; Bennis, 2007; Pearse, 2017). This, Day says, “ignores almost 50 years of research” (Day, 2000, p. 583). However, while Day (2000) acknowledges the interrelatedness of both leader and leadership development, he offers no framework linking the two that practitioners might use to develop the personal characteristics that engender leadership effectiveness on the one hand, as well as the social, relational and contextual practices that catalyse the learning of leadership and the effective application of the learned skills, on the other hand.

Moreover, DeRue and Myers (2014) have argued that defining learning of leadership from the leader development perspective, where only the knowledge, skills and abilities of the leader are considered to be nurtured, is limiting because it does not recognise the complex nature of leadership as an "interactive process among multiple actors who are both leading and following, or that the relationships that are created and maintained within the social context can have a strong influence on how leadership processes emerge and develop" (DeRue and Myers, 2014, pp. 834–835). However, DeRue and Myers (2014) also recognise the proximal role that leader development can have in improving leadership and not just the individual skills, as long as the approach to development includes ways of learning social and relational skills. "Leader and leadership development are interdependent. Developmental experiences or interventions designed to promote more effective leadership relationships will also affect individuals'...[knowledge, skills and abilities]…beliefs and motivations. Likewise, actions taken to enhance individual leadership capabilities will indirectly alter the landscape of leading-following relationships among actors" (DeRue and Myers, 2014, p. 835). This view of leader development suggests that criticisms hurled upon leader development approaches as unable to address the comprehensive nature of leadership (Barker, 1997; Day, 2000, p. 200; Bolden, 2010; Edmonstone, 2011; Mabey, 2013; Day *et al.*, 2014), only look at developmental experiences in the narrow sense of those related to cognitive and intrapersonal capabilities. Yet if well designed, leader development approaches are expansive in nature and can take the form that integrates the learning of relational and social skills (Collins and Holton, 2004; Mumford, Campion and Morgeson, 2007; Mumford *et al.*, 2017; Liu *et al.*, 2020).

Whereas Day's (2000) comparative dimensions of leader and leadership development are useful, in the natural sciences such as health care, the development of the individual leader is an entrenched practice (Stoller, 2008, 2009; Bronson and Ellison, 2015). Day has concluded that the "preferred approach is to link leader development with leadership development such that the development of leadership transcends but does not replace the development of individual leaders" (Day 2000, p. 605). However, the relationship between a supervisor and follower is critical for performance, and some have argued that this needs to be a focus of leader training (Mäkelä, Tanskanen and De Cieri, 2020). Edmonstone (2011) has suggested that a balance of both is useful in developing leaders in health care in ways that integrate both. That is, individual characteristics such as integrity, self-awareness and strategic thinking with relational and interpersonal aspects such as relationship-building skills. Moreover, Day (2000) proposed that "the most value resides in combining what is considered the traditional, individualistic approach to leader development with a more shared and relational approach" (Day, 2000 p. 586).

2.6.3 Leader development and deliberate practice

In the early 1990s, Conger (1993, p. 46) argued that leader development was approached by many organisations in a “haphazard” fashion without intentionality, and that such approach to training though could have worked in the past, would not suffice in the new and complex world, now popularised by the U.S. Military as VUCA (volatile, uncertain, complex and ambiguous). Unfortunately, this haphazard approach is still ubiquitous today largely because extant literature is not conclusive on what approaches work best, and neither have leader development programmes been sufficiently evaluated to ascertain the efficacy of different approaches (Burgoyne, Hirsh and Williams, 2004; Backus *et al.*, 2010; Grint, 2011; Lacerenza *et al.*, 2017). Mumford *et al.* (2000) attempt to answer the question “How can we develop people to ensure effective leadership?” (Mumford, Marks, *et al.*, 2000, p. 88) by examining what experiences nurture particular leadership skills at different levels of the organisation. Mumford *et al.* (2000) found that advanced problem-solving and social skills were more prevalent at senior leadership levels. However, the developmental model was built on the experiences from the U.S. Army and may not be relevant in a civilian setting, much less in a public sector organisation riddled with politics and distinctly different leader promotion culture. Their classification of senior and junior roles mirrored the Army’s, where it typically takes years of experience in supervision at a level before one is elevated to the level of greater responsibility, a phenomenon that does not necessarily arise in natural science fields where typically, technical qualification supersedes years of experience at lower levels.
On-the-job learning is touted as critical in leader development, but this experience seems to have been limited to workplace and adulthood experience. The literature has hitherto largely ignored the contribution of early childhood experiences, post-adulthood experiences and experiences outside the workplace in the development of the leader.

The Centre for Creative Leadership proposes a 70-20-10 convention as a guiding framework through which organisations can develop leaders, claiming that it emerged out of 30 years of its own research (Centre for Creative Leadership, 2020). The rule practised in many organisations guides that seventy per cent of learning ought to come from challenging assignments at work, twenty per cent from mentoring relationships and ten per cent from formal training. However, Clardy (2018) criticises the rule as weak, having been conceptualised from frivolous research lacking in rigour and empirical evidence, especially for the 70 per cent informal learning. Some scholars suggest that it is misleading to many leader development organisations and, at best ought to be a guideline and not a rule (Lombardo and Eichinger, 2010; Jennings, 2015; Clardy, 2018). Moreover, Liu *et al.* (2020) have argued that whereas the 70/20/10 rule is popular, it is not validated. Liu *et al.* (2020) contend that this view of leader development largely arising from the adult’s working environment is deficient. They assert that leader development requires an exploration of the requisite development needs and how they can be met to inculcate the skills needed to lead and the leader's self-view and that therefore these needs can be met through a holistic view of developmental experiences spanning time and contexts such as home, work, childhood, family, and school, community, country—all of which are influenced by "historical, social, and cultural factors" (Liu *et al.*, 2020, p. 3). This suggests a strong influence on the leader development experiences and leadership effectiveness of natural scientists, who by the nature of their industry, the community of practice, and subjective norms and societal expectations have a unique context (Collins-Nakai, 2006; Blumenthal *et al.*, 2012; Colcleugh, 2013; Perry *et al.*, 2017; Dias, Mathew Joseph and Michael, 2019; Miles and Scott, 2019).

Liu *et al.* (2020, p. 1) advise that not all activity is relevant for leader development, noting that "The influencing mechanism of experiences during the leader development process has been understudied." Only those that are sufficiently complex and offer a degree of challenge have a potential to become relevant developmental experiences. People do not automatically learn from experience and not every experience can be used to develop leadership. The process requires intentionality, practice and reflection for developmental experiences to impact leadership (Day, 2010). Liu *et al.* (2020, p.3) called it "deliberate practice for behavioural reinforcement." They add that these aspects, including feedback, mentors support and the leaders' self-awareness, despite their influence on how people learn from experience are not sufficiently studied in the literature.

2.6.4 Leader development and experience

The pre-eminence of experience in engendering learning of leadership skills has been well articulated by proponents of experiential learning, as outlined in section 2.4.1 above (DeRue and Wellman, 2009; Kolb, 2014; Liu *et al.*, 2020). In fact, the value of experience to leadership has been overemphasised perhaps more dramatically by McCall (2004). "The primary source of learning to lead, to the extent that leadership can be learned, is experience" (McCall, 2004, p. 127). This view of leader development that denigrates other approaches to learning is supported by Day (2000) who has warned that "Classroom programs suffer from transfer of training challenges and high start-up costs, among other limitations" (Day, 2000, p. 586). Raelin (2011) concurs, suggesting that when people learn outside of the environment in which they practice, they may come away with an understanding of a list of traits and competences but which they cannot practice once they are back to the workplace. However, some studies show that training programmes (even in the natural sciences) can be effective (Backus *et al.*, 2010; Blumenthal *et al.*, 2012; Lacerenza *et al.*, 2017) and that training at universities can contribute to the learning of leadership (Ewing, 2009; Hodge *et al.*, 2011; Perry *et al.*, 2017). Moreover, Kaagan (1998, p. 74) asserts that, "Leadership development is about teaching leadership," and therefore this process ought not to be restricted to specific experiences but a multiplicity of opportunities on the journey for growth (Kaagan, 1998; Collins and Holton, 2004; Day *et al.*, 2014; Liu *et al.*, 2020). Kaagan (1998) argues that it is misleading to assume that leadership development comes mostly from engaging with the problems and issues in the organisation through day-to-day experiences. Reflecting on what he calls the 'tenets of good teaching', he suggests that spending time away from day-to-day work problems can have the effect that leaders overcome "dysfunctional patterns that plague them in the workplace" (Kaagan, 1998, p. 77).

He also argues that expensive 'away from work experiences' like team building excursions do not in themselves necessarily bring experiential learning unless particularly crafted by an able facilitator to allow for exercises and reflections that align to the desired learning goals and aid the participants to conceptualise and apply the learning. Experiential learning, therefore, is not just the experience but how the experience is used to draw out the lessons, often through reflection. For example, utilising and building on Dewey's (1938) and Schon's (1986) work, Kaagan (1998) contends that a 'a rose is a rose', and the out of the workplace 'constructed experience' such as a classroom is not any less real from that of the regular workplace, but that well-crafted exercises and facilitated case studies in an off-site environment offer better learning opportunities given the psychological safety available to participants to be themselves and the fact that they are not caught in the hustle and bustle of daily demands. Additionally, he emphatically argues that the necessary "safe ground" and subsequent "reflection-in-action" through rigorous examination of current practice, "cannot take place within the confines of an organization's work space" (Kaagan, 1998, p. 80).

According to Kaagan (1998), while it is important to immerse leaders into their regular experiences and problems to bring out learning, much greater learning comes from combining both the familiar and unfamiliar, and crafting a reflective process that enables the learners to challenge the value of what they do and how they do it, in relation to the goals they seek. This can be achieved both at work and in off-site settings since at the core essence of leadership are social, interpersonal and cognitive skills that can be learned from natural as well as constructed experiences (Dewey, 1938; Kolb, 1984; Mumford, Marks, *et al.*, 2000; Day *et al.*, 2014). Moreover, McDermott, Kidney and Flood (2011) intimate that leadership skills development is an individual experience and that there is no one best way, given the expansiveness of influencing factors such as individual, organisational and industry characteristics. Further, according to DeRue and Myers (2014), leadership can be learned more effectively where personal attributes such as developmental readiness and learning orientation accentuate the experience (Avolio and Hannah, 2008). "Leadership development occurs primarily through action-based learning and experience, but not all experiences are equally developmental; and challenging assignments can be formal or informal, direct or indirect, and vary greatly in terms of their content" (DeRue and Myers, 2014, p. 849).

Therefore, the current study considers all experiences (constructed or otherwise, formal or informal) as relevant for leader development and seeks to examine the unique and relevant experiences and practices that leaders holding positions in natural science fields found relevant to the growth of their leadership skills.

2.6.5 Leader development and skills

Mumford, Marks *et al.* (2000) explain that skills development from a performance-based perspective implies that the determinants of skills acquisition in the early stages of learning new skills (such as intelligence) differ from those in the latter stages of further skill development (such as focus). Expertise develops slowly over time (Mumford, Marks, *et al.*, 2000; Ropo and Parviainen, 2001; McCall and Hollenbeck, 2008; Goodall and Bäker, 2015). Therefore, the learning of leadership, like other skills, is cumulative in nature, and it may need years of practice for a novice in leadership who starts out with mundane and well-structured tasks under intense supervision as they learn what is expected of them in an organisation, then moves into supervisory roles where they have a degree of independence but still working on structured problems and well-defined roles. It is building on this at a later stage of skill acquisition that the leader can work on wicked problems that are novel to the organisation, and therefore, the leader depends on complex relationships within the workplace to attempt to collaboratively solve such systemwide issues.

> It may take up to 20 years before leaders acquire all of the skills needed to solve novel, ill-defined organizational problems. Moreover, development in this sense is progressive, moving from simple knowledge structures and straightforward technical and social skills, to complex integrated knowledge structures that support the effective application of creative problem-solving and systems skills (Mumford, Marks, *et al.*, 2000, p. 91).

Accordingly, the approaches needed to develop skills for the novice may require simple guidance and training on key processes and Standard Operating Procedures (SOPs), and principles on solving traditional problems, while the required approach for the seasoned leader may require mentorship and coaching that allows for greater self-awareness and emotional intelligence (Burgoyne, Hirsh and Williams, 2004; Day *et al.*, 2014). While Mumford, Marks *et al.* (2000) present a conceptual model for leader development, they acknowledge that leader development does not happen automatically by following these pre-defined pathways. There are other mediating factors to learning, in particular, the kind of experience, context and individual characteristics that affect learning. “Self-initiated application of principles can accelerate the development of expertise” (Mumford, Marks, *et al.*, 2000, p. 88). For example, lack of openness, a strong ego, or poor self-image may impede the learning of leadership while self-drive, a growth mindset and developmental readiness may promote learning (Dweck, 1986; Avolio and Hannah, 2008; DeRue and Ashford, 2010). Furthermore, Mumford, Marks *et al*. (2000) highlight that both the leaders' interpretation of environmental events and the opportunities the environment itself provides have an impact on the learning of leadership skills. For example, several scholars have found that exposure to challenging and complex problems has an effect of stimulating the learning of problem-solving skills (McCall, 2004; Farr and Brazil, 2009; Matsuo, 2015). "Assignments, such as sales and marketing assignments, may promote the development of other types of skills, including the interactional, communication and systems skills needed by leaders" (Mumford, Marks, *et al.*, 2000, p. 95). However, some have argued that this learning from challenging experiences only happens when the leader adopts a growth mindset (Dweck, 1986; Heslin and Keating, 2017).

2.7 Approaches to leader development

According to Liu *et al.* (2020), organisations spend millions of dollars on developing leaders but do not often take into account the cumulative nature of leader skills development and therefore the leadership development experiences individuals bring to their roles—insights that are essential not only in selection and promotion but also in developing a more comprehensive view of the leadership development journey one has taken and what more they can learn in their everyday operations (Lacerenza *et al.*, 2017; Geerts, Goodall and Agius, 2020; Liu *et al.*, 2020). The result is that a custom-tailored journey for the gaps that might still exist may not be encouraged.

Kouzes and Posner (2012) reviewed a number of case studies and ascertained that people learned how to lead from a variety of approaches including experimentation, observing others, and formal education or a combination of these. Liu *et al*. (2020) have argued that previous definitions of leader development focus on the skills and behaviours that are learned on one's quest to become a better leader and therefore do not align to the non-outcome-based standard for construct explication. They offer the following definition,

> [leader development is] the process by which one increases his or her ability to exercise influence in leadership situations that become increasingly more complex and varied, during the lifespan process with multiple developmental stages and various contexts. Leader development as a multidimensional development process includes intrapersonal, interpersonal, and organizational level influence one has inside and outside of leadership roles to help drive individuals toward performance goals (Liu *et al.*, 2020, p. 3).

This definition connotes a cumulative aspect of learning leadership similar to Mumford's *et al.* (2007) strataplex phenomenon. It emphasises the multifaceted nature of experiences, contexts, and stages through the leader's life journey but also maintains the goal of development to be the improved capability to influence others towards a performance goal whether that be within a formal leadership role or not, within an organisation or outside it. The current study's framing of leader development approaches, therefore, includes all activities undertaken during the lifespan to learn leadership skills and does not limit the experience of the natural scientists examined, only to their roles or to their specific organisation. Concurring with Mumford's *et al*. (2007) conceptualisation of leader development as the acquisition of skills in a strataplex, DeRue and Myers (2014) aver that leadership development has three developmental outcomes—behavioural, motivational and cognitive. They suggest that developing these requires an integrative framework that looks beyond individual leader skill and incorporates approaches that tap into the social context to help leaders benefit from experience. The authors say, "Without an integrative understanding of the inputs, processes, and outcomes associated with leadership development, organizations are forced to speculate or rely on intuition as to what to develop, how to develop it, where and when it should be developed, and who is ready (or not ready) for development" (DeRue and Myers, 2014, p. 848).

Despite considerable scholarly work on leader development in the past decades, there is still insufficient illumination on what must be done to address the leadership talent crisis (Collins and Holton, 2004; DeRue and Myers, 2014; Dopson *et al.*, 2016). Looking at the overemphasis on intrapersonal skill, DeRue and Myers (2014) call for an integrating and organising framework to guide leadership development. They have proposed the PREPARE framework even though in presenting the same, they call for further research that might look at the interrelationships between the inputs and the "individual, relational and collective outputs of leadership development" (DeRue and Myers, 2014, p. 835).

2.7.1 Lifespan approach to leader development

Liu *et al*. (2020) posit an 'experiential windows' model which illuminates openings in which one can develop leadership skills at different stages in life. The model highlights six stages and the possible suite of activities that would be necessary at each stage to nurture leadership capability. Several scholars have found empirical evidence to support the lifespan approach to leader development right from childhood (Day, Harrison and Halpin, 2009; Day, 2011; Day and Sin, 2011; Murphy, 2011; Murphy and Johnson, 2011; Eldad and Benatov, 2018; Liu *et al.*, 2020).

1. **Nascent stage**. This first stage, consists of the first six years where the individual first obtains their view and nature of leadership, their view of self and relationships with others, from the way their parents and caregiver relate with them. Secure attachment to parents at this stage,

often characterised by a positive social environment and comfort, is a predictor of stronger transformational leadership, social capital and emotional intelligence in future years as opposed to insecure attachment that leads to leaders with a lack of trust in a team environment. In addition to attachment security, engaging in play activities such as team games and pretend play enables the child to practice leadership behaviours, learn interpersonal and social skills and conceptualise their leader identity.

2. **The externally driven stage**. This refers to the age 6-12 where the child gets involved in household chores (which nurtures a sense of responsibility) learning from school (modern teaching incorporates collaborative learning where projects and tasks are completed in teams, which enables children to learn leadership skills), engagement with siblings (where older children adopt and practice a leadership role) and other community activities where they interact with and learn from the influence of people of authority, learning key skills such as negotiations, communications and task-orientation (Day, 2011; Murphy, 2011; Murphy and Johnson, 2011; Eldad and Benatov, 2018).
3. **Experimental exploration stage**. This refers to the adolescent stage, age 12-18. At this stage the individual consolidates the concept of self, and identity as they explore the world around. They should therefore be given opportunity to lead independently in contexts such as family, school and community. This can take the form of leadership in extracurricular activities at school such as sports, art and drama, volunteering. Additionally, the interactions with peers at this level as the adolescents navigate peer-pressure and belonging can be essential in developing their social and emotional intelligence, critical capabilities for leadership (Murphy and Johnson, 2011). Parents also provide role models as leaders, training and guiding the learner about leadership (Eldad and Benatov, 2018; Liu *et al.*, 2019).
4. **The emerging adulthood stage** consists of ages 18-30. This is regarded as a primal adult development stage given the trends that adults are engaging in major events such as marriage and childbearing much later in life. Leader development here is driven by what people value and the expected outcome of an opportunity. Engaging in leadership courses (where one can learn strengths and weaknesses, acquire knowledge and develop a leader identity), is essential in leader development. Leadership courses can be part of the university experience, or the emerging adult can participate in leadership activities at the university such as in student guild affairs, residence, clubs and student organisations, religious communities or sports. At this stage, one can take on internship opportunities or be employed in a job, both of which present opportunities to practice and learn leadership through challenging assignments and the interaction with the first supervisor (who acts as a role model to affirm or debunk the individuals' hitherto implicit leadership theory). This is also the stage where romantic relationships emerge. These kind or relationships are critical in nurturing social skills,

interpersonal skills and relationships skills, which, from the perspective of relational leadership theory are very critical to leadership.

5. **Purpose-driven stage**. This stage consists of adulthood, 30-60 years, where individuals are laden with responsibility and have to balance family, work and other priorities. Engaging in purpose seeking activities such as mindfulness, meditation and prayer can strengthen self-awareness, and a connection to one's intrinsic values, can lead to leadership effectiveness. Leadership development is often through leadership development programmes for high potential individuals within the organisation, with many left to learn leadership on their own. Leader development programmes may include training, coaching, and action-learning. Adults at this stage, "care about a sense of meaning and purpose," and if they find the programme not relevant and helpful, "may not be motivated to implement the takeaways after the completion of such programs" (Liu *et al.*, 2020, p. 8). In this stage, being charged with critically important work and responsibility in a complex and uncertain setting can quickly trigger the learning of leadership skills. Complex work might include launching a new product, promotion, representing a superior in a high-stakeholder negotiations, or leading a diverse team. This is the stage where the responsibilities of marriage and parenthood heighten the need and opportunity for leader development.
6. **Legacy-making stage**. This stage, late adulthood (over 60) is characterised by the desire to make a lasting impact on society and leader development activities might include the individual taking on the role of mentor, coach or trainer for in-house organisational development programmes. These individuals, usually senior executives, therefore engage in succession planning processes to nurture and develop the next generation of leaders or volunteer to provide guiding leadership at community level. Retiring leaders may also participate as members of boards to advise and mentor senior executives or they may author books to share their knowledge widely and mentor others at a distance.

2.7.2 Leadership training

Many organisations engage in leadership training whether in a classroom setting such as executive MBAs and leadership courses or via distance learning and training workshops, but few find their programmes effective (Burgoyne, Hirsh and Williams, 2004; Raelin, 2011; Day *et al.*, 2014; Lacerenza *et al.*, 2017). Leadership training is defined more broadly to include activities that are "systematically designed to enhance leader knowledge, skills, abilities, and other components" (Lacerenza *et al.*, 2017, p. 1687). This includes both classroom based and off-site training workshops. However, for the proponents of experiential learning, classroom training has been criticised as not effective (Day, 2000; Raelin, 2011). Day (2000, p. 586) has criticised the idea that leader development primarily happens under the aegis of "specially designed programs held in particular locations" as naïve. He suggests that leadership can be learned from daily experiences at work and elsewhere (Day, 2000, 2010; Liu *et al.*, 2020). Intentionality in leveraging the experience does not necessarily mean a prescriptive approach that relies heavily on classroom programmes (Conger, 1993; Day, 2000; Raelin, 2011).

However, despite the criticisms, some literature suggests well-designed classroom training programmes work. In a meta-analysis of research examining how effective leadership training programmes are, Collins and Holton (2004) found consistency with previous literature highlighting that training was associated with positive outcomes among leaders. They suggested, however, that more research was required to understand which approaches work more effectively. In a recent research, Lacerenza *et al*. (2017) confirm the value of training programmes arguing that, "leadership training is substantially more effective than previously thought, leading to improvements in perceptions of utility and satisfaction, learning, transfer to the job, organizational outcomes, and subordinate outcomes" (Lacerenza *et al.*, 2017, p. 1707). The authors highlight the nature of the design and delivery that makes one training more effective than another. For example, they advise that use of multiple delivery methods "e.g., information, demonstration, and practice" (Lacerenza *et al.*, 2017, p. 1704), multiple time spaced sessions and where programme content is aligned to business outcomes, enhances effectiveness.

2.7.3 Developmental approaches

According to Day (2000), some practices in organisations often initiated for other reasons such as performance management, have innate capacity to address leadership development, albeit not as an intentional exercise. These include, "360-degree feedback…executive coaching, mentoring …networking, …job assignments and action learning" (Day, 2000, p. 587). The current study builds on this work by examining the experiences of leader development within the context of expert leaders in natural sciences and in an African developing country setting.

2.7.3.1 360-degree feedback

Day describes 360-degree feedback as a "method of systematically collecting perceptions of an individual's performance from the entire circle of relevant viewpoints" (Day, 2000, p. 587). Multi-rater and multiplicity of viewpoints enable the recepient of the feedback to understand performance as viewed from multiple consitituents and enhances feedback reliability (Leslie and Fleenor, 1998; DeShon *et al.*, 2004; Ryan, Henderson and Phillips, 2019). This approach is also helpful in enhancing self-awareness and self-understanding and when deployed effectively, can be used by individuals to improve social capital and interpersonal relations through the enhanced understanding of the impact of one's behaviour on others (Burgoyne, Hirsh and Williams, 2004; Day *et al.*, 2014). Using the Centre for Creative Leadership's three-pronged development strategy of 'assessment, challenge and support', Day (2000) suggests that 360-degree practices are strong on assessment but weak on the rest. Some scholars have found that multi-source feedback is essential for a leader's growth and performance given its ability to illuminate blindspots, expand the leaders self-awareness and emotional intelligence (Mainemelis, Boyatzis and Kolb, 2002; Boyatzis, 2008; Boyatzis, Rochford and Cavanagh, 2017; Truninger *et al.*, 2018)—capabilities essential for the social skills and that have been found to improve the performance among engineers and medical scientists (Boyatzis, Rochford and Cavanagh, 2017; Goodall and Stoller, 2017; Geerts, Goodall and Agius, 2020).

However, many organisations have found 360-degree feedback fashionable, implement them haphazardly and very few use these assessments appropriately to nurture leadership development due to a lack of appreciation on how to deploy the tool effectively beyond conducting the assessments (Day, 2000; Conger and Toegel, 2002; Boyatzis, 2008). Evidence from leaders in the medical field suggests that when used correctly, e.g. as part of a tiered leader development programme that includes coaching, 360-degree feedback can lead to improvements in leadership behaviour and perfomance (Lacerenza *et al.*, 2017; Torbeck, Rozycki and Dunnington, 2018). Such asssessments are most effective when combined with other learning strategies such as coaching and mentoring, or when the feedback includes expert observations after an action learning project (Day, 2000; Goodall and Stoller, 2017; Torbeck, Rozycki and Dunnington, 2018; Geerts, Goodall and Agius, 2020). However, an interventional study among clinicians has found that combining multi-rater feedback with leadership training does not always lead to improved leadership skills (Malling *et al.*, 2009). Similarly, in a study of the effectiveness of workplace coaching, Jones *et al*. (2016) found that effectiveness was higher where multi-rater feedback was excluded.

Moreover, concerns about effectively using this learning strategy in an organisational context abound. For example, focusing on the quantitative and discounting the qualiative part, coupling it with performance evaluation, and the unwillingness of individuals to accept feedback, especially the type that might be critical of their performance all affect how feedback can be used for leader development (Day, 2000; Conger and Toegel, 2002). The raters and observers must also have the expertise to give feedback constructively and must demonstrate objectivity and not use it as a tool for retributory practice or unfaireness as this affects relationships, performance and defeats the goal of using the feedback to improve (Conger and Toegel, 2002; DeShon *et al.*, 2004; Sparr and Sonnentag, 2008). Additionally, this learning strategy can be deployed a number of times (usually every six months) to evaluate and encourage progress (Seifert and Yukl, 2010), but raters must be trained to look at the six month period and not the most recent experiences, something that is often not practiced (DeNisi and Kluger, 2000; Conger and Toegel, 2002). Moreover, the process ought to be institutionalised so that managers and their direct reports can discuss the feedback and engage appropriate coaching practice to act on that feedback (Day, 2000).

2.7.3.2 Coaching

Coaching is a process of integrating the aspects of assessment, challenge and support in a one-on-one relationship with a coach and leader in order to change behaviour, improve performance or learn a skill (Day, 2000; Bozer, Sarros and Santora, 2013; Ladegard and Gjerde, 2014; Van Oosten, 2014). Coaching can be one-on-one or one-to-many (team coaching) in a process that challenges and supports the leader to reflect and enhance their performance through new ways of thinking and learning (Berg and Karlsen, 2012). Although coaching has been mostly applied for performance improvement, it is increasingly being applied to leadership development (Berglas, 2002; Grover and Furnham, 2016; Kirk, Kania-Richmond and Chaput, 2019). Coaching has been identified as one of the most impactful and efficacious intervention for leader development (Berg and Karlsen, 2012; Korotov, 2017; Albizu *et al.*, 2019; Frick, 2019). It has been associated with improvement in leadership behaviour (De Haan, Gray and Bonneywell, 2019; Kirk, Kania-Richmond and Chaput, 2019), self-efficacy and leader confidence (Stewart *et al.*, 2008), leader performance (MacKie, 2014; Jones, Woods and Guillaume, 2016; De Haan, Gray and Bonneywell, 2019), leader integrity awareness (Van der Walt and Van Coller-Peter, 2020), and goal attainment, resilience and well-being (Grant, Curtayne and Burton, 2009).

According to De Haan *et al*. (2013), coaching effectiveness is affected by the relationship between the coach and coachee, the coaching technique, personality differences, and the self-efficacy of the coachee (Stewart *et al.*, 2008; Grant, Curtayne and Burton, 2009). Other authors also note the influence of the selections process and organisational support (Carey, Philippon and Cummings, 2011; Grover and Furnham, 2016; Korotov, 2017). However, several scholars have argued that the relationship is the most important ingredient in the process (Boyce, Jackson and Neal, 2010; Ely *et al.*, 2010; De Haan *et al.*, 2013; De Haan, Gray and Bonneywell, 2019). Van der Walt and Van Coller-Peter (2020) and MacKie (2014) have suggested that positive leader outcomes are attainable where a strength approach is applied while Bowles *et al*. (2007) found that goal-based coaching was effective. However, while De Haan *et al*. (2011) acknowledge the mediating aspects of coaching techniques on outcomes, they found that a precise coaching approach may have no impact on the outome; rather, it is a combination of many that is associated with positive outcomes (Ely *et al.*, 2010; Carey, Philippon and Cummings, 2011; De Haan, Culpin and Curd, 2011; De Haan *et al.*, 2013). However, some scholars suggest that the factors that make coaching effective are not well understood and therefore require further study (Jones, Woods and Guillaume, 2016; De Haan, Gray and Bonneywell, 2019; Frick, 2019).

Some authors have suggested that coaching is effective since it provides a platform for reflection and feedback to the leader in an safe confidential environemnet clothed with non-judgement (Jones, Woods and Guillaume, 2016). In this regard, to enhance confidentiality, non-judgement and the credibility of the process, professional coaches outside of the organisation have been suggested (Sue-Chan and Latham, 2004; Carey, Philippon and Cummings, 2011; Berg and Karlsen, 2012). However, other authors such as Critchley (2010) have argued that coaches are not impartial or non-judgemental but that they are influenced by the meaning-making process, organisational context and agendas and the coach-coachee relationship. Coaches must therefore be professional in their approach not only to maintain a healthy relationship of mutual trust but also to avoid creating attachment (Ely *et al.*, 2010; Korotov, 2017).

Critics of coaching have argued that the lack of professionalism and the proliferation of self-styled coaches who are not extensively trained in psychology is outright dangerous, as such people may let their clients ignore underlying mental health or psychological problems (Berglas, 2002). However, Berglas (2002) as a practicing coach and trained psychiatrist, argued from a perspective of the need for organisations to recognise the value that psychotheraphy can provide to organisations. This critism of coaching unfairly lumps the discipline of coaching together with other interventions such as counselling, psychotheraphy, consulting or cognitive behavioral therapy. Professional coaches are well trained and posses a set of competences and skills to meet the needs of the individual, including how to recognise when coaching is insufficient and where other remedial (medical or psychological) interventions might be necessary (Ely *et al.*, 2010). Moreover, as Carey *et al.* (2011) have found, even within the coaching approach, there is a tapestry of interventions that vary significantly. Coaching as a practice should, therefore, not be criticised for what it is not. Coaching is a relationship based one-on-one learning process focused on achieving the performance and professional development goals of an individual as they are challenged and supported by an external (professional) or internal (peer or manager) coach, and may have multiple forms including leadership development coaching, performance coaching, life coaching (Day, 2000; Ely *et al.*, 2010; Carey, Philippon and Cummings, 2011; Korotov, 2017; Lacerenza *et al.*, 2017).

Perhaps due to its prohibitive costs, most organisations approach executive coaching from a remedial perspective and typically assign coaches to struggling leaders, which as Day (2000) observes could bring stigma and negatively impact the process. Coaching can be effectively deployed to anyone in the organisation and aligned towards specific goals and outcomes over a short or long-term period (Bozer, Sarros and Santora, 2013; Passarelli, 2015). Further, Day (2000) warns that, "if coaching is not purposefully and strategically applied, it is a waste of time and money that dilutes the value of a development opportunity" Day (2000, p. 591). For effectiveness, Day (2000) suggests that coaching ought to be combined with feedback, and like Bozer, Sarros and Santora (2013) have argued, once rooted in enhancing emotional intelligence, coaching enhances leader effectiveness (Day, 2000; Bozer, Sarros and Santora, 2013; Van Oosten, 2014).

2.7.3.3 Mentoring

Mentoring has been defined as processes where an experienced leader or senior executive through sharing of personal experience, provides guidance to a protégé as part of the latter's leader development journey (Ahles, 2005; Lee and Hur, 2015; Mazzoccoli and Wolf, 2016; Juma and Jordans, 2020). This process of guidance includes role modelling (Day, 2000; Solansky, 2010; Tabloski, 2016). According to Day (2000, p. 595) mentoring "is a dynamic and complex mixture of coaching, modelling, and feedback" which might present risks of over-dependence where the mentor-protege relationship could be called to question by outsiders or the protege failing to perform autonomously (Day, 2000; Lester *et al.*, 2011; Straus *et al.*, 2013).

Mentoring can be formal, with the organisation matching a senior leader to a junior leader, outside the usual line management relationship where the former provides support for growth to the latter. It can also be informal where these relationships emerge outside the monitoring and control of the organisation (Day, 2000; Lester *et al.*, 2011; Mazzoccoli and Wolf, 2016). Mutooni, Ng'weno and Jordans (2020) have suggested that as leaders in Africa are being challenged to adopt new styles rooted in empathy and doing good, they have had to rely on informal mentoring relationships considering most have not had any formal leadership development programmes. Both informal and formal mentoring are relevant in assisting the organisation to establish the optimal mix (Hong and Idris, 2015; Nakanjako *et al.*, 2015; Clardy, 2018). It sometimes becomes difficult to separate mentoring from coaching, especially where the mentor is an external consultant. Day (2000) suggests that there are more positive outcomes linked to informal in contrast to formal mentoring. Mentoring can also take the form where the senior leader chaperones the junior in meetings or functions so that the junior has a first-hand account of how leadership works (Gedro *et al.*, 2020). Mentorship has also been found to be a significantly practiced approach among health professionals during clinical placements, although it is often ad hoc and rarely done well (Mormina and Pinder, 2018). Additionally, mentorship relationship during a leader's university experience can enhance self-leadership (Lee and Hur, 2015). Mentorship can increase the protégé's confidence, attitude towards feedback, leader efficacy and performance (Lester *et al.*, 2011).

However, mentoring can be limiting to the protégé, considering that the mentor's experiences and context might not align to the protégé's context or learning needs (Straus, Chatur and Taylor, 2009; Koya, Sice and Rauch, 2016). Additionally, it is a method that many mentors use without training, muddling through it with approaches that are laden with risks to create dependencies—thereby disempowering the mentee (Straus *et al.*, 2013). Moreover, matching the right mentor-mentee relationship is often difficult, yet a strong collaborative, communicative, mutually respectful relationship with an experienced mentor is essential for effectiveness (Straus, Chatur and Taylor, 2009; Gonçalves and Bellodi, 2012; Straus *et al.*, 2013). Furthermore, with the crisis of character and lack of integrity in leadership, many good mentors are rare, or where a protégé has a mentor, they often fail to appreciate the infallibility of the mentor or to acknowledge the imperfections as areas to disregard and not normalise (Bennis, 2007; Stewart *et al.*, 2008; Van der Walt and Van Coller-Peter, 2020).

2.7.3.4 Networking

Day (2000) has described networking as "a means of encouraging organization members to form commitments with others outside of their immediate work group…as a way of building support and social capital needed for problem-solving" (Day, 2000, p. 596). Rice *et al.* (2020) have suggested that networking increases collaboration opportunities and development among scientists, such as in nursing. Additionally, some authors have argued that traditional leader development approaches may not meet the needs of today's professional and that online resources and networking present a new opportunity (Salmon *et al.*, 2015; SHRM, NOCA, and EFMD, 2016; Hoffman, Yeh and Casnocha, 2019; Moldoveanu and Narayandas, 2019). Moreover, according to Imperial *et al.* (2016), the kind of problems organisations are facing require a collaborative inter-organisational effort where organisations are networked, therefore requiring extensive leadership skills and the ability to cultivate networks with others (De Brún and McAuliffe, 2020). Ibarra and Hunter (2007) have categorised networking in terms of operational, personal and strategic networking. Operational networking relates to cultivating the relationships needed to perform a role effectively; personal networking requires relationships to expand one's influence, and strategic networking—which Ibarra and Hunter (2007) argue is the ultimate test of leadership—is when the leader cultivates relational capital outside the organisation that is essential in the achievement of the organisation's objectives.

Networking enables the creating of opportunities for senior leaders to interact with peers and juniors. It might be during lunch meetings, watercooler moments or intentionally designed events both face-to-face or through virtual teleconferencing. The goal is for individuals to share mutual challenges and brainstorm on possible solutions, building a social network (through trust building) needed for problem solving and innovation (Cullen-Lester, Maupin and Carter, 2017; Rice *et al.*, 2020). These peer relationships last longer and can be the bedrock of informal learning and leadership development. Day (2000) suggests that the more informal these relationships are, the better and that organisations should nurture them through encouragement, and linking them to feedback, mentoring and coaching interventions rather than attempt to formalise them. Networking enhances the social interaction necessary for leadership development as it transcends the formal hierarchy and power structure, enabling leaders to interact more effectively together (Day, 2000; Ibarra and Hunter, 2007).

However, networking as a learning strategy for leader development has been frowned upon by those who might perceive it as unethical or manipulative, time-consuming and sleazy, if they believe that they are developing relationships in exchange for favours rather than relying on their authentic competences (Ibarra and Hunter, 2007; Casciaro, Gino and Kouchaki, 2014; Cullen-Lester, Maupin and Carter, 2017). Furthermore, it is not a learning strategy that comes naturally to all leaders, it may be more aligned to those with extraversion personality types, and systemic organisational practices may make it more difficult for women to make the most of such a strategy (Cullen-Lester, Maupin and Carter, 2017). According to Cullen-Lester, Maupin and Carter (2017), once leaders debunk the misconceptions about networking and adapt relevant strategies, such as providing value to others before asking something in return, finding a sponsor, or arranging for one-on-one talks, leaders can find these social networks meaningful opportunities to learn and grow rather than activities to feel dirty about (Ibarra and Hunter, 2007; Casciaro, Gino and Kouchaki, 2014; Cullen-Lester, Maupin and Carter, 2017).

2.7.3.5 Job assignments

Assigning challenging jobs for on-the-job learning is increasingly recognised as a critical approach in developing leaders (Evans, 1992; Dragoni *et al.*, 2009, 2014; Carbery and Garavan, 2011; Chuang, 2013; Liu *et al.*, 2020). It has been recognised particularly in building strategic thinking, influencing, and team building skills—core skills at the higher levels of leadership, according to Mumford's strataplex (Mumford, Marks, *et al.*, 2000; Mumford, Campion and Morgeson, 2007). This, as Day (2000) argues, is because of the challenge aspects of the process (DeRue and Wellman, 2009; Saxena *et al.*, 2014). Day (2000) opines that its effectiveness as an approach could be enhanced through the addition of assessment and support elements say by more appropriately matching the job assignment to the development needs (Conger and Toegel, 2002; Boyatzis, 2008).

This development approach can take the form of leader rotation to new and unfamiliar departments or locations, stretch assignments into roles that expand the leaders skills and require higher levels of skills in the strataplex, for example, those that bestow more responsibility, demand building of stronger relationships with more senior leaders and stakeholders or solving more complex problems (Day, 2000; Saxena *et al.*, 2014; Kjellström, Stålne and Törnblom, 2020; Kjellström, Törnblom and Stålne, 2020). It also helps if the organisation, in its succession planning, positions leaders in a developmental challenge role, where failure is likely but would provide a learning experience, even at the expense of immediate business needs (Day, 2000; Torbeck, Rozycki and Dunnington, 2018; Yu *et al.*, 2018). As

Day suggests, "negative experiences or hardships tend to promote learning and trigger self-reflection" (Day, 2000, p. 599; Kjellström, Törnblom and Stålne, 2020).

2.7.3.6 Action learning

Baird *et al*. (1999) conceptualised action learning as different from learning from action. The latter being intent on the process of review after the action, in order to assess whether the strategic intent of the action was achieved, why it was or not achieved, key lessons learned in the experience and how and with whom to share the lessons in order for the learned lessons to stick. According to Baird *et al*. (1999), this practice of after-action reviews, originating from the U.S. Army is what is essential to the learning process. "The issue becomes how to help individuals, groups and organizations learn from their performance. Performing and learning are not sequential or overlapping, but learning is a by-product" (Baird, Holland and Deacon, 1999, p. 19).

People learn best when addressing real-time organisational challenges (McCall, 2004; DeRue and Wellman, 2009; Heath and Heath, 2017). Action learning is a contrast to the traditional classroom approach to learning leadership, which many are shunning away from in light of the limited learning transfer after the training (Pollock, Jefferson and Wick, 2015). Whereas the practice is strong on the challenge and support, Day (2000) suggests that it can be improved by added emphasis on assessment, so that the ideal project is aligned to the ideal candidate for leader development. The nature of the approach requires an organisational challenge or project to be identified and leaders working on the project identify the goals, the issues affecting reaching those goals and then work collaboratively to solve them, after which they also reflect on how implementation went (Baird, Holland and Deacon, 1999; Rigg and Richards, 2006; Leonard and Lang, 2010; Walia and Marks-Maran, 2014). This after-action review processes, which follows the learning by doing, amplifies the learning from action opportunity (Baird, Holland and Deacon, 1999; Day, 2000; Leonard and Lang, 2010). Moreover, Day (2000, p. 602) argues that, "not every developmental need can be addressed in every problem context," individuals championing a specific project must identify the business imperative it is contributing to but also the developmental goals that this challenging project can easily contribute to. That then enables the identification of which leaders ought to be enlisted to the team for purposes of both solving the problem and learning. The approach is now a popular practice for building leadership skills (Masango-Muzindutsi *et al.*, 2018). Discussing Hicks and Peterson's (1999) Leadership Development Model, which compares the effectiveness of various methods, Leonard and Lang (2010) underscore action learning's pre-eminence as an approach found to be strong on all aspects of what they called the "necessary and sufficient elements for learning and sustained development…[which include] insight, motivation, skill development, real-world practice, and accountability" (Leonard and Lang, 2010, p. 227).

However, despite its popularity as a learning strategy for leader development, some scholars argue that it is poorly implemented (Conger and Toegel, 2002; Rigg and Richards, 2006; Burgoyne, 2009; Leonard and Lang, 2010). Chief among the problems identified in action learning, is that too often projects are set up without a comprehensive assessment of the skills the action is seeking to build, to whom such learning must be matched and therefore the necessary experiences needed to nurture the development of intricate knowledge (Conger and Toegel, 2002). Revans (1991, 2011) suggests another problem—failure to balance between the action and learning as the problem from which the learning must happen is often a real world pressing issue—not allowing time for reflection, which is fundamental to action learning (Raelin and Raelin, 2006; Cho and Egan, 2009). Conger and Toegel (2002) emphasise that to improve action learning in practice, regular scheduled reflection moments should be integrated in the design of the project, experienced facilitators are required and that painstaking follow-up of project results is essential.

Section 2.7.3 has enumerated the leader development approaches that extant literature suggests are relevant in developing leaders. These are summarised in Tables 2.1 and 2.2 below. The activities make up the specific approaches examined in this study, particularly in the qualitative exploratory phases to assess exposure and relevance among natural scientists.

Table 2.1 Summary of leader development approaches

Leader development approach	**Summary of approach in the literature**	**Source**
Formal Training Programs and Short courses	Classroom training is essential and is often the first approach for many organisations in search of leader development solutions. However, it ought to be the least applied given that other methods are more effective. Bolden (2010) reports that the trend in many organisations is changing from one-off courses to a development journey. Formats are also changing from didactic lectures and presentations to interactive, participatory and experiential approaches. This approach includes management training such as MBAs, and short courses provided by training companies and consultancies.	(Burgoyne, Hirsh and Williams, 2004; Bolden, 2010; Raelin, 2011; Lacerenza *et al.*, 2017; Hoffman, Yeh and Casnocha, 2019)
Mentoring and Role Models	This involves "advising/developmental relationship, usually with a more senior manager" (Day, 2000, p. 588). Pairing can be with a senior manager or external consultant. The arrangements can be formal or informal. Mentoring can be individual or group based. Successful leader development programmes have included mentoring	(Day, 2000; Ahles, 2005; Giber *et al.*, 2009; Solansky, 2010; Lee and Hur, 2015; Mazzoccoli and Wolf, 2016)
Coaching	Though there might be stigma linked with being allocated a coach, and therefore impede its effectiveness, this approach provides focused one-on-one learning and development driven from the individual leader's growth agenda to improve performance. Coaching, especially when rooted in emotional intelligence and 360 degree feedback processes, has been found to have an impact on leader effectiveness	(Day, 2000; Bozer, Sarros and Santora, 2013; Ladegard and Gjerde, 2014; Van Oosten, 2014; Passarelli, 2015)
Self-Directed Learning	The leader's confidence and belief in themselves to learn leadership (self-efficacy) drives their pursuit of knowledge and the extent to which they apply themselves to learning opportunities including self-directed opportunities such as books, videos, podcasts, journaling, MOOC and reflective learning.	(Avolio and Hannah, 2008; Hannah *et al.*, 2008; Harms, Spain and Hannah, 2011; Machida and Schaubroeck, 2011; Salmon *et al.*, 2015; Hew, 2016; Heslin and Keating, 2017; Liu *et al.*, 2020)

Leader development approach	Summary of approach in the literature	Source
Experiential Learning	Learners actively influence the learning environment and vice versa. Support from someone more experienced, learning on the job, and the learner's own interpretation of why he/she succeeds or fails at a challenge (social constructivism) all have an impact on how leaders learn. Previous learning experience affects the leader's approach to new learning. Learning comes when "knowledge is created through the transformation of experience" (Yardley, Teunissen and Dornan, 2012, p. 162). First originated by Kurt Lewin and subsequently improved by Kolb (1984), the experiential learning approach has been a common feature in the medical field and other technical fields. The workplace context is a source of applied knowledge.	(Lewin, 1946; Lewin *et al.*, 1951; Kolb, 1984; Stanton and Grant, 1999; Day, 2000; Armstrong and Mahmud, 2008; Ng, Van Dyne and Ang, 2009; Yardley, Teunissen and Dornan, 2012; Matsuo, 2015; Heath and Heath, 2017; Liu *et al.*, 2020)
Action Learning	This approach covers project-based learning focused on organisational challenges and problems. Revans argues that leaders and their organisations, cannot thrive unless their learning matches or surpasses the rate of change. In this approach, leaders, rather than depending on expert trainers and the organisation's priority of the skills one must develop, choose what makes the most meaning for them. They are driven to learn from their day-to-day activities largely by questioning the past for insight rather than glorying in it for self-aggrandisement.	(Revans, 1982, 1991; Hicks and Peterson, 1999; Burgoyne, 2009; Leonard and Lang, 2010)
Feedback culture	Feedback is particularly important in learning leadership whether it is integrated as part of coaching, mentoring or other approaches. How feedback is encouraged and applied in the organisational context has implications for learning leadership. For example, creating moments where leaders discuss feedback with the people giving it increases development capability and so does repeated feedback.	(Day, 2000; Conger and Toegel, 2002; Burgoyne, Hirsh and Williams, 2004; Day *et al.*, 2014)

Leader development approach	Summary of approach in the literature	Source
Reflective Learning	Consistent with other social learning theories, learning happens from everyday experiences. One has to evaluate the insights learned from each activity for best practices. Learning is greatly enhanced when the leaders have a strong learning goal orientation. After action reviews and critical moments, reflection methodologies are examples of reflective learning.	(Kolb, 1984, 2014; Kriflik and Kriflik, 2006; Dragoni *et al.*, 2009, 2014; Kolb and Kolb, 2009a; Gilbert, 2016)
360-degree Assessments	A popular approach - "systematically collecting perceptions of an individual's performance from the entire circle of relevant viewpoints" (Day, 2000, p. 587). As Day adds, by itself this approach "is strong on assessment but weak on challenge and support" unless practitioners build-in the mechanism to use expansive data over time to provide guidance on how the leader can change.	(Day, 2000; Burgoyne, Hirsh and Williams, 2004)
Academic Training in Technical Field	Expert knowledge influences organisation strategy, increases affinity to technical leaders among followers who see the leader as "one of us". Enables deeper appreciation of context that aids in goal setting, allocation of work, evaluation and support. Increases credibility	(McCall and Hollenbeck, 2008; Goodall and Bäker, 2015; Allison, Goodall and Bastiampillai, 2016; Goodall, 2016; Mazzoccoli and Wolf, 2016)
Soft-skills training within Technical Courses	The expert leader is a strong feature of leadership within technical fields. Leaders are expected to be experts in their technical area before they rise to the top. Training in the core technical competences enables them to develop confidence, capabilities and credibility to lead. Additional training given to these leaders also includes soft-skills training in areas such as communication, listening, and collaboration	(Gifford and Finney, 2011; Allison, Goodall and Bastiampillai, 2016)
Personality Assessment and other Self-awareness Interventions	Psychometric tests integrated with coaching, training and reflection to enable the leader to be more self-aware, and therefore develop capabilities to manage their emotions and build stronger relationships with others. Developing self-awareness and the emotional intelligence that draws from it are therefore foundational approaches in nurturing and birthing what Day (2000, p. 584) and others have advanced as "the fundamental leadership imperatives."	(Goleman, 1995; Zand, 1997; Day, 2000; Hall, 2004; Gilbert, 2016; Avolio and Hannah, 2020; Liu *et al.*, 2020)

Leader development approach	Summary of approach in the literature	Source
	Specifically, “individual leader’s knowledge, trust, and personal power.” (Day 2000, p. 584). Social awareness—the leader’s ability to be aware of the impact their interaction has on others is essential in developing the leader.	

Table 2.2 Leader development approaches more likely to engender leadership effectiveness

Leadership Development Approach	**Power to effect leadership skills as studied in other contexts**	**Relevance in engendering higher-order thinking skills and transformational learning**	**Source**
Coaching	HIGH	HIGH	Bozer, Sarros, and Santora (2013) (Ladegard and Gjerde, 2014; Passarelli, 2015; Taylor, Passarelli and Van Oosten, 2019)
Mentoring—leader-to-leader development	HIGH	HIGH	(Solansky, 2010; Lester *et al.*, 2011; Lee and Hur, 2015; Gumus and Bellibas, 2016; Mazzoccoli and Wolf, 2016)
360-degree feedback assessments	HIGH	MEDIUM	(Rosti and Shipper, 1998; Conger and Toegel, 2002; Burgoyne *et al.*, 2004)
Stretching work/additional responsibility/Acting in a role, learning by doing	HIGH	HIGH	(Heath and Heath, 2017; Owusu *et al.*, 2017; Park *et al.*, 2017; Graham, 2020)
e-learning courses (webcasts, webinars, self-directed & social media, MOOC)	LOW	LOW	(Wilson and Fowler, 2005; Backus *et al.*, 2010; Paksoy, 2015)
Postgraduate training/ Masters level course in leadership/management (e.g., MBA) or residency training	MEDIUM	MEDIUM	(Burgoyne *et al.*, 2004; Rubens *et al.*, 2018; Ziemba *et al.*, 2018)
Leadership Forums, networking events and conferences to interact with senior leaders.	LOW	LOW	(Backus *et al.*, 2010; SHRM, NOCA, and EFMD, 2016; Lacerenza *et al.*, 2017)
Participation in leadership roles during university undergraduate study (Such as Faculty, Sports, Residence, Social Clubs, Fellowships, Research Projects)	HIGH	HIGH	(Ronald *et al.*, 2011; Perry *et al.*, 2017; Liu *et al.*, 2020)
Self-Awareness & feedback on Personality assessments and Psychometric test	MEDIUM	MEDIUM	(Wood and Bandura, 1989; Harms, Spain and Hannah, 2011; Caldwell and Hayes, 2016; Rubens *et al.*, 2018)
Personal reading, self-directed study and reflection, continuous professional development	LOW	LOW	(Gumus and Bellibas, 2016; Lacerenza *et al.*, 2017; Graham, 2020; Liu *et al.*, 2020)

Source: Own

Table 2.2 above shows the select approaches and the extent to which they appear to be impactful in leader development as studied in contexts outside of the natural sciences.

2.8 Leadership in the natural sciences

Bak-Maier and Williams (2013, p. 1) have posited that "Engineers and scientists experience a complex career challenge when transitioning from a subject specialism, or subject matter expert to a leadership position within the organization." The common problem is that in promoting the best scientist into a leadership role, where more time is spent on leading others (inspiring, coordinating, organising, and developing) and less as an individual contributor through technical tasks, "the organisation loses the best engineer and gains the worst leader" (Perry *et al.*, 2017, p. 3). Existing literature suggests that the process of developing expertise in technical fields such as the natural sciences takes years, and because of the premium attached to excellence in technical skills, little room is left for natural scientists to engage in developing social skills and other leadership competencies (Guthrie, 1999; McCall and Hollenbeck, 2008; Farr and Brazil, 2009; Stoller, 2009; Colcleugh, 2013; Mazzoccoli and Wolf, 2016; Geerts, Goodall and Agius, 2020), including "strategy, communication, persuasion, motivation, and myriad people skills" (Perry *et al.*, 2017, p. 3). Some have argued that adding leadership skills and related competencies in communication and management bestows a competitive advantage to scientists and improves effectiveness; and that this requires multiple approaches to skill development (Wefes, 2020).

Some scholars have argued that leadership in natural science fields has unique characteristics due to its unique contexts (Edmonstone and Western, 2002; Winter Institute, 2007; Edmonstone, 2011). Medical workers, for example, have a hierarchy of seniority and leaders emerge to the top, largely based on their technical competence rather than their leadership competence (Stoller, 2008, 2009; Nakanjako *et al.*, 2015; Perry, Mobley and Brubaker, 2017; Agyepong *et al.*, 2018). Leaders in technical fields are those who supervise scientists, engineers, technicians, agriculturalists, health and biomedical professionals and other specialised personnel in organisations within the natural sciences. Gifford and Finney (2011, p. 3) define technical experts as "people whose professional and personal identities had been built around a very specific area of technical knowledge," in fields such as engineering, agriculture and medicine. Gifford and Finney (2011, p. 3) argue that the "leadership development needs of technical and professional experts have much in common and are significantly different from more generalist management populations." The natural sciences are a branch of science that rely on biology, physics and chemistry and often study these subjects from a positivist perspective. Natural sciences include technical specialisations such as engineering, agriculture, medicine and health and all disciplines that are not concerned with the social (Bhaskar, 1982; Sapienza, 2007; Barthel and Seidl, 2017).

It is inevitable that those who hold supervisory positions over scientists have to learn to manage conflicts, communicate effectively, motivate scientists and organise people, systems and resources in order for their teams and organisations to succeed at the scientific endeavours (Sapienza, 2007). Leadership, therefore, matters among natural scientists. However, technical skills have long been given a much greater weight in the natural sciences, yet as globalisation and organisational complexity expand, technical success has increasingly moved from being the top expert's gambit and more of a multidisciplinary team effort—escalating the need for leader effectiveness (Sapienza, 2007; Stoller, 2008, 2009; Goodall and Carmichael, 2018; Nyssa, 2019).

Unlike in the social sciences, the role of leadership in the process of achieving a coordinated performance towards a collective goal has been ignored in the natural sciences, until recently (King, Johnson and Van Vugt, 2009; Perry *et al.*, 2017; Rooke, 2018). For example, Lim, Li and Fang (2020), comment that despite its mediating effect on hospital preparedness and response readiness, the role of leadership is overlooked. Amanda Goodall, a proponent of the expert leadership theory argues that there has been a move towards generalist leaders in organisations and strong criticism of expert leaders when in fact there would be higher performance if leaders had expertise in their organisation's specialist area (Goodall and Carmichael, 2018). Goodall (2016) and Allison, Goodall and Bastiampillai (2016) assert that hospitals would perform better with a clinician at the helm. Similarly, engineers at the helm of engineering firms, scholars leading academic institutions, and expert drivers in charge of Formula One (Goodall and Pogrebna, 2015; Allison, Goodall and Bastiampillai, 2016; Goodall, 2016). Technical fields have long adopted this view and promote their best experts to the helm. Yet, because of a frustration with the leadership effectiveness of expert scientists, the appeal of generalists at the top has only increased (Guthrie, 1999; Stoller, 2009; Goodall and Bäker, 2015; Geerts, Goodall and Agius, 2020).

Despite this, very few organisations and educational programmes have an elaborate process for equipping technical natural scientist leaders in soft skills and those that do, have only begun recently, albeit with unclear strategies for design and delivery that are known to work (Stoller, 2008, 2009; Brungardt, 2011; Geerts, Goodall and Agius, 2020). Moreover, the training they receive during undergraduate training is often devoid of soft skills and interpersonal relations training (Elrod and Kezar, 2014; Perry *et al.*, 2017; Akdere, Hickman and Kirchner, 2019). Additionally, natural scientists carry a condescending attitude towards the value of social sciences and its methods (Viseu, 2015; Barthel and Seidl, 2017). However, it is aspects of social science that father the understanding of people and breed leadership effectiveness. As Barthel and Seidl (2017, p. 4) point out, "Social sciences are termed 'social' because they deal with humans, their values, preferences, motivations, perceptions, rationales and decisions, from the individual to the collective (societal) level."

Graen, Wakabayashi, Graen, and Graen (1990) advance that tasks in professional work contexts are characteristically less structured and therefore require greater self-management. Rost (1993) found that leadership in hospitals was bureaucratic and followed a leader-member exchange. Moreover, some scholars have suggested that transformational leadership is not customarily practical in professional bureaucratic settings—which are ubiquitous in natural sciences (Pawar and Eastman, 1997; Politis, 2002; Pawar, 2003). It appears therefore, that leadership defers in the natural sciences and whereas scientists, for example in a laboratory setting might focus their energies on the science itself, success in this realm is undoubtedly attenuated by conflict, poor communication, and poor motivation leading to low productivity. Furthermore, the process of attracting, developing and retaining good talent as well as planning, creative thinking and problem solving—all aspects of leadership, are essential for performance in the natural scientist's world (Farr and Brazil, 2009; Chuang, 2013; Colcleugh, 2013; Mumford *et al.*, 2017). Leaders in this field must therefore balance scientific rigour and skill with competence in dealing with people and emotions (Parker and Hackett, 2012). Moreover, as Evans (1992) advocates, leaders in the natural sciences need to add to their repository of technical expertise, the requisite soft skills in order to be more effective in their leadership. Evans differentiates between leaders who see themselves as 'experts' and "lead by their technical authority" (Evans, 1992, p. 1), and those who identify as 'generalists', who "lead by management skills" (Evans, 1992, p. 1). Evans (1992) distinguished them by their attitudes towards soft skills, approaches to delegation, and situational leadership competencies. He concluded that leaders ought to balance the skills of professional expertise and generalist leadership and that this leadership development could be attained through experience across departments and changing careers.

2.8.1 Leadership in COVID-19 times

By March 2021, there were reported to be more than 114 million cases and 2.53 million of the 2019 Novel Coronavirus Infectious Disease (COVID-19) worldwide. As a result of this pandemic many health professionals have found themselves at the forefront of leading national efforts, some of them, they have never prepared for, and having to demonstrate authentic leadership and trust building in order for the public to trust them and follow their leadership (Ahern and Loh, 2020; Kaul, Shah and El-Serag, 2020; Lobdell *et al.*, 2020; Moore, 2020; Stoller, 2020; Häyry, 2021). Despite the news of the vaccine presenting hope and respite, globally, nations continue to suffer disruptions to socio-economic life due to public health measures such as restrictions on travel and meetings (Alwan *et al.*, 2020; Belhadjali and Abbasi, 2020). The global pandemic has created significant challenges for leaders. In times of unprecedented uncertainty, leaders play a significant role in raising employee morale and mobilising their support by articulating a vision for the future the mechanisms to make the change happen (Kotter, 2007; McMullin and Raggo, 2020). Moreover, as organisations have had to adapt to remote working, the need for e-leadership has escalated. According to Contreras, Baykal and Abid (2020), the pandemic has escalated the adoption of e-leadership but the risks of remote working remain strong as some leaders have only transferred their traditional leadership styles into the remote world. E-leadership requires that leaders adjust away from the traditional hierarchical structure, build strong trustworthy relationships with their teams and leverage soft skills such as empathy, communication skills, social skills, teambuilding skills, and trustworthiness in addition to change management and ICT skills (Van Wart *et al.*, 2019; Contreras, Baykal and Abid, 2020). The e-leader need not be a tech expert, but they must elevate their expertise in leadership (especially the social skills) to be able to harness the potential of their team without being disadvantaged by the technology or social distance (Tietze and Musson, 2005; Stokols *et al.*, 2009; Wojcak *et al.*, 2016; de Vries, Tummers and Bekkers, 2019; Van Wart *et al.*, 2019).

Leaders have had to master managing in a crisis and complexity in an ever changing uncertain environment (Abubakar *et al.*, 2020; Belhadjali and Abbasi, 2020; McMullin and Raggo, 2020). Whereas skills such as crisis communications, empathy, trust building, decision-making and resilience were needed before, the global outbreak has heightened the need for leaders to demonstrate these skills even more (Bartsch *et al.*, 2020; Kaul, Shah and El-Serag, 2020; Strack *et al.*, 2020). With teams working remotely, leading dispersed teams effectively has become critically important (Bartsch *et al.*, 2020; Contreras, Baykal and Abid, 2020). Other skills demanded of leaders include leading through a crisis, innovating and business remodelling and looking outwards to pivot into new sales channels and supply chains, leading change, developing agility within the team, risk mitigation, emotional intelligence and developing leaders using virtual coaching and online training (Belhadjali and Abbasi, 2020; Binagwaho, 2020; Dirani *et al.*, 2020; Kaul, Shah and El-Serag, 2020; Moore, 2020). According to Kaul, Shah and El-Serag (2020), leading effectively in such times requires humility, letting go of control so as to draw in many followers into the decision-making process, abandoning dogma and being open to new ideas, communicating extensively, and staying on course on the core values and long-term view of the organisation's mission.

The need to build and sustain trust has become even more essential as leaders are being asked to make difficult decisions at an organisational level such as job and pay cuts or at a national level such as instituting public health measures restricting movement, business and normal day-to-day life (Binagwaho, 2020; Strack *et al.*, 2020). As some scholars have suggested, if there ever was a time to demonstrate the highest level of leadership soft skills, it is in pandemic crisis times such as the COVID-19 outbreak (Ahern and Loh, 2020; Belhadjali and Abbasi, 2020; Koehn, 2020). In times like these, people turn to leaders for solutions (Belhadjali and Abbasi, 2020; Kaul, Shah and El-Serag, 2020). However, some authors say that while the pandemic has brought untold suffering, any crisis breeds innovation and presents opportunities for growth (Kaul, Shah and El-Serag, 2020). This, however, does not happen automatically and leaders have to reflect through such traumatic experiences to draw the lessons (Conger and Toegel, 2002; Kaul, Shah and El-Serag, 2020). As Kaul, Shah and El-Serag (2020) have advised, "The most important priorities for a leader in the early postcrisis phase include a rapid assessment of the existing landscape at all levels (administrative, clinical, academic, and financial) as well as the humility and wisdom to recognize the lessons learned….the progressive leader will identify new paradigms and opportunities that present themselves as a result of such a crisis" (Kaul, Shah and El-Serag, 2020, p. 811).

The need for trust building, collaboration, empathy and humility as the ideal style of effective leadership compared to hierarchical styles, has been accentuated by the pandemic (Ahern and Loh, 2020; Binagwaho, 2020; Nsabimana and Jordans, 2020; Stoller, 2020), notwithstanding that recent literature suggests that this type of leadership is difficult to develop within the natural sciences settings (Goodall and Stoller, 2017; Ahern and Loh, 2020; De Brún and McAuliffe, 2020; Geerts, Goodall and Agius, 2020; Graham, 2020). This study, therefore, contributes to the literature by examining experiences and identifying approaches that are effective in nurturing among scientists, the kind of collaborative leadership espoused in the post COVID-19 world.

2.9 Methods for studying leadership in natural sciences

Not many authors examine the influence of the context on how leadership is practiced (Pawar, 2003; Brazier, 2005) or how it is learned, measured or studied (Day, 2000; Antonakis *et al.*, 2004; Day *et al.*, 2014). Brazier (2005) stressed the value of appreciating context and its effect when striving for transformational leadership. Some scholars have therefore called for context-specific models of leader and leadership development in order to address this gap in natural science fields (Collins-Nakai, 2006; Blumenthal *et al.*, 2012; Medcof, 2017; Miles and Scott, 2019). The current study contributes to addressing such gaps in the literature by studying the natural sciences' context and its influence on leader development (Fairhurst, 2009).

2.9.1 Mixed methods

Mixed methods as a research choice is essential in integrating multiple data points, thereby increasing rigour and real-world relevance in the study context (Ma, 2012). Mixed methods enable a deeper understanding of leadership within context, and theory building (Böhme *et al.*, 2012). Furthermore, Parry *et al*. (2014) aver that progressive leadership research demands mixed methods; say by using the qualitative aspects to "examine the effect of context on general conclusions flowing from survey studies" (Parry *et al.*, 2014, p. 149).

Often associated with radical empiricism, the natural sciences have espoused quantitative methods as the legitimate means to establish knowledge (Cobern, 2000; Nuijten, 2011). Nevertheless, given the interconnectedness of the challenges facing the world, with tentacles across disciplines, there is a growing drive to adopt a multidisciplinary approach to research even on the matters related to natural science problems (Nuijten, 2011). Natural scientists are tending to combine approaches and methods predominantly popular in the social sciences (Nuijten, 2011; Viseu, 2015; Barthel and Seidl, 2017; Siponen and Klaavuniemi, 2020). Surprisingly, the positivist view and pre-eminence of quantitative approaches still dominates leadership research even within the social sciences (Ashford and Sitkin, 2019). Researching leader development does not easily lend itself to the 'gold standard' scientific approach—the double blind randomised controlled trial. It is mostly retrospective and researchers often have limited control over any intervening variables. That notwithstanding, as Kaptchuk (2003) argues, "Good science inevitably embodies a tension between the empiricism of concrete data and the rationalism of deeply held convictions. Unbiased interpretation of data is as important as performing rigorous experiments" (Kaptchuk, 2003, p. 1453). A pragmatic approach with mixed-methods has therefore been recommended in interdisciplinary research, of which leadership development research is (Nuijten, 2011; Morgan, 2014; Barthel and Seidl, 2017; Siponen and Klaavuniemi, 2020). Moreover, Burgoyne (2009) argues that pragmatism provides insights on what capability through learning can be developed by neither focusing on the extreme approaches of the positivist or the social constructionist approach. According to Liu *et al.* (2020), studying leadership from multiple disciplines enables the emergence of a more comprehensive view of the leadership phenomenon. By integrating methods, theories and researching natural scientists in a multiplicity of disciplines, the current study brings forth a picturesque perspective to leadership.

Conger (1998) and Parry *et al*. (2014) advocate that though rare, qualitative studies ought to be the defacto go-to methodology for highly contextual subjects like leadership. Similarly, Liu *et al*. (2020) note that despite the value that qualitative studies bring to our understanding of leadership, current literature is littered with quantitative approaches. "Although much of our emphasis is on quantitative, empirical studies, qualitative research will also help to better understand how leadership develops at different stages of life" (Liu *et al.*, 2020, p. 14). They add that though "current qualitative study methodologies are not often amenable to scientific reproduction and replication" (Liu *et al.*, 2020, p. 14), they can, with adherence to proper coding and scientific techniques bring additional value to the literature. Moreover, because of its reflective process, qualitative inquiry offers extensive flexibility for the researcher's questions to evolve as the understanding of the phenomenon increases and the researcher moves closer to the study objective (Corbin and Strauss, 2008; Agee, 2009).

Nonetheless, considering that leadership is complex, it is important that qualitative methods whose strengths lie in phenomenon exploration are complemented by quantitative approaches, whose value-add is in hypothesis testing (Antonakis *et al.*, 2004). In his assessment of methodologies and approaches that are best suited for studies such as the current study, where a link between leader development, context, the intervening step and performance is being investigated, Burgoyne (2009) argues that new methodologies are needed and suggested that critical realism was the most promising. Thorpe (2018) applied a similar method to explore leader development in a specific population—women in educational leadership. Additionally, Fletcher (2017) applied it to develop causal linkages in a qualitative study.

According to Avolio *et al*. (2009), research methods in the current literature are insufficient to reveal the complexity of the answers we seek on leadership, thereby limiting our understanding of leadership. Avolio *et al*. (2009) have noted a number of criticisms and limitations of methods adopted in extant literature. "Leadership research has focused on the research methods used to examine leadership impact on follower performance…is beset with the overuse of small convenience samples with cross-sectional designs…'simple bi-variate correlations'…designs [that] limit the conclusions that can be drawn from the accumulated leadership literature" (Avolio *et al.*, 2009, p. 764).

2.9.2 Comparative case studies

Discussing the weaknesses in contingency theory research, Yukl (2011) recommends that in the study of leadership, researchers need to adopt research methods that can improve the understanding of existing theories. Among such methods, he calls for comparative case studies as opportunities to illuminate how different leaders behave in different situations or contexts. "Instead of relying so much on survey field studies with convenience samples, it is desirable to make more use of other relevant research methods. Examples of methods that are likely to be useful include comparative field studies of effective and ineffective leaders in different situations" (Yukl, 2011, p. 296). Comparative case studies may combine both qualitative and quantitative approaches, thereby enabling the leveraging of each method's strengths (Lijphart, 1975; Rihoux and Ragin, 2008; Bennett, 2012; Ma, 2012). Additionally, such an approach provides rigour through a fuller understanding of the phenomenon under study in the case but also any alternative but plausible explanations outside the case (Dooley, 2002; Levy, 2008; Rihoux and Ragin, 2008; Houghton *et al.*, 2013; Yin, 2018; Van Mieghem *et al.*, 2020).

Case studies are one of the research strategies identified in the research onion in the layers before time horizons, techniques and procedures (Saunders, Lewis and Thornhill, 2016; Melnikovas, 2018). Despite their extensive use, the literature is awash with misconceptions about what case study research is, or how it works, with many defining the method from a narrow perspective (Yin, 2018). For example, Yin (2018) has noted that some definitions dwell on a specific case (e.g., 'decisions' vs 'programmes' or 'institutions') rather than the method itself—which is applicable to a variety of cases. Yin (2018) also notes that other definitions confuse the research strategy with participant observation, which is a data collection technique. Supporting this mischaracterisation of case study methods, Flyvbjerg (2006) examines and dispels five common misunderstandings as outlined below:

> (a) theoretical knowledge is more valuable than practical knowledge; (b) one cannot generalise from a single case, therefore, the single-case study cannot contribute to scientific development; (c) the case study is most useful for generating hypotheses, whereas other methods are more suitable for hypotheses testing and theory building; (d) the case study contains a bias toward verification; and (e) it is often difficult to summarize specific case studies (Flyvbjerg, 2006, p. 219).

Similar to Yin (2018), Flyvbjerg (2006) makes the case that out of misunderstanding and confusion, existing literature unfairly diminishes the value and power of case study research and that as a research method, it is essential in generating good theory, generalisation and in scientific progress. Moreover, Flyvbjerg (2006) emphasises the power of context in learning and developing expertise. He asserts that "experts…operate on the basis of intimate knowledge of several thousand concrete cases in their areas of expertise. Context-dependent knowledge and experience are at the very heart of expert activity. Such knowledge and expertise also lie at the center of the case study as a research and teaching [and] more generally…as a method of learning" (Flyvbjerg, 2006, p. 222). In other words, research and inquiry, as an approach to learning, benefit greatly from case study methods and their pragmatist paradigm (Denzin, 2010; Creswell, 2012; Morgan, 2014). He concludes that, "the case study is a necessary and sufficient method for certain important research tasks in the social sciences, and it is a method that holds up well when compared to other methods in the gamut of social science research methodology" (Flyvbjerg, 2006, p. 241).

Yin (2018) comprehensively defines the case study strategy (research method) as an "empirical…social science research method, generally used to investigate a contemporary phenomenon in-depth and within its real-world context" (Yin, 2018, p. 46). He adds that as a scientific inquiry method, it therefore benefits from a rigorous approach that leverages a theoretical underpinning to "guide design, data collection, and analysis…and as a result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion" (Yin, 2018, p. 46). Furthermore, Houghton *et al.* (2013) applied the case study strategy in the context of nursing, a natural sciences field, and they observe that the method is useful in studying phenomenon within its natural setting and that "multiple case studies allow comparisons, particularly in diverse settings" (Houghton *et al.*, 2013, p. 12). Similarly, other scholars have identified the case study approach as a strategy that brings rigour when multiple data collection sources and techniques are utilised to examine plausible alternative explanations (Dooley, 2002; Levy, 2008; Yukl, 2011; Houghton *et al.*, 2013; Yin, 2018).

The idea that case studies only depend on qualitative research and that are useful only for exploratory research is a simplistic misconception (Yin, 2018). Moreover, Yin (2018) suggests that case studies are excellent choices and preferred methods when the research questions relate to the 'how' and 'why', and adds that "some of the best and most famous case studies have been explanatory case studies" (Yin, 2018, pp. 37–40). The current study, therefore, adopted a comparative case study strategy, leveraging both its descriptive and exploratory power (to understand the practices of leader development among natural scientists) and its explanatory power (to assess the unique practices among natural scientists as compared to non-scientists and why such practices are relevant in developing leadership effectiveness). The integration of qualitative and quantitative approaches during data collection attenuated the weaknesses associated with each and optimised the strengths. Moreover, allowing for comparative analysis to be conducted across multiple cases (scientist and non-scientist institutions, and multiple natural science sub-disciplines—such as agriculture, medicine, engineering) increases the rigour and credibility of this explanatory research method (Dooley, 2002; Rihoux and Ragin, 2008; Yin, 2018).

2.10 Gaps in the literature

In a paper proposing how to estimate the return on leader development investments, Avolio, Avey and Quisenberry (2010) observe that "Leadership development is the least explored topic within the field of leadership research and theory" (Avolio, Avey and Quisenberry, 2010, p. 634). According to Day (2000, p. 582), there is a "dearth of scholarly research directly on the topic [of leadership development]." Similarly, Kaagan (1998) says the leadership development literature puts a strong emphasis on who should do the development, where the learning experiences should be and when—the timeframe—in which it should occur, but very little focus is put on the what and how. According to Kaagan (1998), the questions of content and methodology are central to learning and ought to supersede the who, when and where questions when considering any leader development programmes. "Directing the eye away from content and methodology increases the possibility that they will remain underexamined. If the attention is dispersed, then the amount of inquiry directed at any one element will likely be insufficient. This is the case with the present state of the literature on leadership development" (Kaagan, 1998, p. 78). Surprisingly, two decades later, leadership researchers still concern themselves with who should be developed (Avolio and Hannah, 2020). While there is an emerging consensus on methods for leadership development (Day *et al.*, 2014) and competence development (Wallo *et al*., 2020), because of the enduring myths on leadership and how it can be developed, Avolio and Hannah (2020, p. 1) have encouraged "scholars and practitioners alike to get past whether, and focus on figuring out what can be developed and how."

Many organisations approach leader development in a haphazard fashion without intentionality and due process (Conger, 1993; Day, 2000, 2010; Kouzes and Posner, 2012). Recent literature suggests there continues to be a lacklustre approach to leader development and a focus towards individual leader traits rather than providing leaders with targeted experiences and approaches for leadership development, a direction where new research is expected to focus (Cohen, 2019; Avolio and Hannah, 2020). This is, in part, because despite the extant literature on different approaches to leader development, little is known about their relative effectiveness and what works in specific contexts (Day *et al.*, 2014; Lacerenza *et al.*, 2017; Perry *et al.*, 2017). Mumford *et al.* (2007) provided a strataplex of skills needed at various levels, illuminating the capabilities most relevant and aligned to specific leadership roles, but his model was based on research in a military setting and tested in a public-sector government organisation in the developed economies (Mumford, Marks, *et al.*, 2000; Mumford, Campion and Morgeson, 2007). Moreover, the model presents the required skills but does not enumerate what kind of practices nurture such skills and competences. The result is that many scholars have called for additional research to fill some of these gaps. Geerts, Goodall and Agius (2020) report that due to the exorbitant costs of leader development, scholars and practitioners are calling for “further empirical clarification about specific, effective approaches to, and benefits of, different types of leadership programs” (Geerts, Goodall and Agius, 2020, p. 14). Further, recent literature suggests that there is need to explore ways to flatten the leader development learning curve (Gedro *et al*., 2020), examining mechanisms and approaches that can nurture collective leadership in a medical setting (De Brún and McAuliffe, 2020), and how expert clinicians can be helped to develop leadership skills to address the paucity of literature ubiquitous in clinical settings (Graham, 2020). Furthermore, Wallace *et al.* (2021) contend that despite the enormous investments in leader and leadership development, the science on approaches effective approaches to leadership development remains immature with an acute lack of appropriate models for development and measurement of learning outcomes. Moreover, in the context of Uganda where the current study is situated, there is limited research on leader development among scientists, with some scholars reporting approaches such as mentorship and training albeit with a huge focus on building technical capabilities such as grant writing, research, and policy analysis and less on development of leadership competences (Nakanjako *et al*., 2015; Agyepong *et al*., 2018).

Hannum and Craig, (2010) have called for more research to better understand leader development programmes. In answering this call, the current study concerns itself with leader development, and not leadership development. This is because, as Day and Harrison (2007) suggest, the former precedes the latter. One cannot develop effective leadership in groups without the individual within being a good leader first (Machida and Schaubroeck, 2011). Lord and Hall (2005) proffered a leader development theory among expert leaders but focused their assessment of critical factors on the individual leader’s aspects; limiting themselves to cognitive elements as the core of developing leadership expertise. In so doing, they ignored the organisational and industry contexts where leader development practices like action learning and experiential learning have a significant impact on leader effectiveness (Conger and Toegel, 2002; Leonard and Lang, 2010; Heslin and Keating, 2017). In addressing this gap, the current study examines both the individual approaches to and contextual influences on the learning of leadership.

Whereas leader effectiveness has been imputed as a notable influence on follower performance and actions (Burgoyne, Hirsh and Williams, 2004; Hannah *et al.*, 2008) and organisational performance (Yukl, 2008; Melo, Silva and Parreira, 2014), recent theories in expert leadership development such as Goodall's (2016) Theory of Expert Leadership (TEL) model that is adapted to psychiatry, a natural science field, do not account for it. The expert leadership model identifies management and leadership skills gained through training and experience as a foundational element; but does not explain how this leader development experience contributes to the resulting leader effectiveness. Given the critical role of leader effectiveness on the overall organisational performance, how leader development links with leadership effectiveness, within the context of expert leaders needs further study. Moreover, while Goodall's (2016) TEL model underscores expertise as a signal for credibility among stakeholders and employees, Shipman and Mumford (2011) found that leadership hubris and overconfidence can dampen leadership effectiveness. Specifically, to address the literature gap, the current study expands on Goodall's (2016) model by integrating it with social identity and planned behaviour theories into a conceptual framework that examines the influence of leader development activities on leadership effectiveness among expert natural scientist supervisory leaders.

Furthermore, some scholars have called for more longitudinal studies with designs that are prospective in nature, arguing that adult retrospective stances looking into the past are laden with "self-serving biases" (Liu *et al.*, 2020, p. 14). However, prospective longitudinal studies are time-consuming and costly, especially in lifespan studies. Therefore, though desirable, such an approach was not feasible for this study.

Liu *et al*. (2020) have also called for more research on leader development to address some of the methodological limitations identified in previous research, particularly focusing on understanding the characteristics of leader development programmes, what processes imbue development, the methods used and outcomes obtained, such as leadership competencies. The authors add that in conducting this kind of research, considerations should be made to enhance generalisability and comparisons between different contexts and specialised groups. This comparative study, examining the context of natural scientists in a multiplicity of subgroups (agriculture, medicine, and engineering) in an African setting and comparing their leader development practices with those of non-scientists in similar contexts, seeks to add to the literature, in part, by responding to that call.

2.11 Theoretical and conceptual framework

Several theories have been advanced to elucidate leader development and learning in general. Some of these have been discussed in sections 2.3 – 2.7 above. Here the most notable ones are discussed and their relevance to guide the current study is examined. Because none of the theories was sufficient to explain leader development within the unique context of natural science leaders, the relevant theories were integrated and synthesised into a conceptual framework that guided the study. The theory of expert leadership (TEL) is the central theoretical framework for the current study. However, the social identity theory and theory of planned behaviour have been integrated with the TEL in order to explain antecedental areas such as contextual influences, and individual characteristics that affect leadership learning but are not part of the TEL.

Firstly, it should be observed that leader development is complex because it transpires alongside adult growth (Day *et al.*, 2014). Secondly, it is also a function of many interrelated influences bearing on the individual's intrapersonal and interpersonal characteristics as well as contextual influences in the organisation, industry or field. Similarly, as discussed earlier, leadership effectiveness is a construct dependent on many personal, behavioural and organisational characteristics. It is, therefore, problematic to identify a single theory to guide a study on leader development in a specialised context. Moreover, as Goodall (2012) observes, leader development practices associated with engendering expert leadership effectiveness is an areas that has not been well studied. This study, however, benefits from a number of theories that provide a framework for the relevant constructs and variables and how they interact. Additionally, the literature provides a number of factors that influence leader development and leadership effectiveness that can be applied to the technical expert fields such as the natural sciences. Two main theories along with their concepts and constructs provided the scaffolding upon which other distal theories added relevant concepts gleaned from the literature to put forward the study's conceptual framework. The two theories include the expert theory of leadership and the theory of planned behaviour. The distal theories that provided some guidance relevant for the study include social-identity theory, implicit leadership theory, social learning theory, experiential learning theory, and cognitive learning theory.

2.11.1 Social identity theory

This theory posits that persons identify themselves and others as members of social groupings and that their behaviour will be dictated by the classification they give of themselves and others. It argues that this social identity governs intergroup behaviour and becomes the principal determinant of social perceptions and behaviour. "People's responses are thus understood in terms of subjective beliefs about different groups and the relations between them, rather than material interdependencies and instrumental concerns, objective individual and group characteristics, or individual difference variables" (Ellemers and Haslam, 2012, p. 379). For example, medical students who might classify themselves as uniquely gifted and superior compared to other health professionals might behave in a manner that demonstrates social dominance. This theory explains how natural scientist might behave as a social grouping in comparison to other groups such as non-scientists and therefore the nature of subjective norms that could affect leader development. It does not however, guide in other areas that impact leader development such as leader characteristics (Murphy and Ensher, 1999; Mumford, Zaccaro, *et al.*, 2000; Bozer, Sarros and Santora, 2013).

2.11.2 Implicit leadership theory

The implicit leadership theory departs from trait-based theories that focus on the capability and characteristics of the leader and proposes that because leadership is a social process concerned with influence, leadership ought to be examined from the perspective of followers. The theory was first proposed by Calder (1977) as attribution theory and highlights that when followers are evaluating leadership effectiveness, they look at group performance or results, the behaviour of the leader (where credibility is gained through display of integrity, emotional intelligence and other behaviours based on the group's normative values, culture and beliefs) and the situation—where contextual factors can explain and rationalise good or bad performance (Eden and Leviatan, 1975; Calder, 1977; Bryman, 1987; Schyns *et al.*, 2011; Epitropaki *et al.*, 2013; Harrison, 2018). The theory has some drawbacks, most prominent being its reliance on a biased view from the followers rather than on what it actually takes to enable the group to reach its goals (Harrison, 2018). The theory, therefore, guided the inclusion of performance and behavioural dimensions in the measurement of leadership effectiveness particularly looking at the leadership skills expected by natural scientists among their leaders—communication, emotional intelligence, performance management, problem solving, innovation, strategic thinking, role ownership and technical competence (Eden and Leviatan, 1975; Bryman, 1987; Birrer, 2002; Stoller, 2008; Farr and Brazil, 2009; Colcleugh, 2013; Miles and Scott, 2019).

2.11.3 Experiential and social learning theory

Experiential learning theory proposed by Kolb (1984) was discussed in section 2.4.1 above. Experiential learning theory proposes that learning will occur once one immerses oneself in a concrete experience and subsequently deliberately reflects upon it in order to evaluate and conceptualise new learning to action through experimentation in ways that creates a new experience—leading to a four-stage cyclical process. The theory also advances that people experience this process differently due to differing learning styles, and that having role models and mentors is more effective than being taught what leadership is (Bandura, 1977; Liu *et al.*, 2020). This suggests that the design of leader development needs a multiplicity of approaches and different experiences. This study, therefore, included a wide range of experiences from which natural scientist leaders could have learned leadership, for examination. Moreover, as Dewey (1938) suggested, experience for learning can be as wide ranging as self-directed reading, formal or informal instruction and any activity in which one is fully engaged and immersed. Similarly, Bandura's (1971) social learning theory contends that learning comes from experience but adds that such experience involves observation and modelling whereby, through trial and error exploration, the successful approach is adopted while the ineffective one is rejected. According to the social learning theory, "new patterns of behaviour can be acquired through direct experience or by observing the behaviour of others" (Bandura, 1971, p. 3). However, some have argued that experience and environmental factors alone do not explain behaviour and that the cognitive element has to be considered. For example, Manz and Sims asserted that, "Social learning theory proposes that an integration of cognitive and environmental determinants yields a more adequate explanation of human behaviour than does focus strictly environmental factors" (Manz and Sims, 1980, p. 363).

2.11.4 The theory of expert leadership

The theory of expert leadership is a recent theory relevant for this study because the natural sciences leaders targeted for this study are expert leaders and the theory suggests that Leadership Capability (LC) predicts expert leader effectiveness and consequently organisational performance (Goodall, 2012; Goodall and Bäker, 2015). The theory is expressed by the function EL = f (IK, IE, LC) and is explained by Goodall below.

> Expert leadership (EL) can be thought of as a function of: inherent knowledge (IK) which is acquired through technical knowledge of the core-business activity, attained through education and practice, combined with high ability in the core-business activity; second, industry experience (IE) which equates to time and practice in the core-business industry; finally, leadership capabilities (LC) which includes management and leadership experience and training, acquired during a leader's earlier career, and his or her innate characteristics (Goodall, 2012, p. 6).

Whereas Goodall (2012) explains that leadership capability (LC) is self-evident, the phenomenon is one of the most debated and its development least understood (Day *et al.*, 2014; Avolio and Hannah, 2020; Geerts, Goodall and Agius, 2020). Nevertheless, the theory suggests that one must also be a good leader on top of the benefits bestowed by his or her technical expertise that make such an expert leader effective. The theory also implies that there is a role that leader development of technical experts plays in the strengthening of inherent knowledge (IK), and industry experience (IE), for example, through education, training and experience. It is plausible that technical experts of equal years of practice will demonstrate varying degrees of IK and IE. There must be processes, experiences, attitudes, actions and personal characteristics that enable one technical expert to develop IK, LC and IE while another does not, something that is well explained by the experiential learning theory, social learning theory, and self-efficacy theory (Kolb, 1984; Murphy and Ensher, 1999; Mainemelis, Boyatzis and Kolb, 2002; Geerts, Goodall and Agius, 2020).

It's these intervening practices that this study sought to identify. As John Maxwell once joked in a motivational speech, "One could boast of 20 years' experience when in reality it's one year's experience repeated 20 times." Kolb (1984, p. 27) asserted that learning is an "emergent process", continuous in nature and forged through the learner's furnace of experience. This study, therefore, adapts Goodall's TEL theory but incorporates other theories that explain how learning, social behaviour and experience relate to leader development and leadership effectiveness (Fiedler, 1964; Ajzen and Fishbein, 1980; Backus *et al.*, 2010; Fishbein and Ajzen, 2011; McDermott, Kidney and Flood, 2011; Heslin and Keating, 2017).

2.11.5 The theory of planned behaviour (TPB)

Ajzen (1991) put forward the TPB which looks at five constructs to illuminate how expert technical leaders approach leader development practices. This theory has been proposed to guide leader development research by Carbery and Garavan (2011) as highlighted in the theory's constructs as follows.

1. **Attitude**. This refers to the attitudes of the technical experts on leader development programmes including expectancies around personal and career growth and training systems, and intrapersonal characteristics that can predict leader development, including personality (Mumford, Zaccaro, *et al.*, 2000; Zaccaro, 2007; Day, Harrison and Halpin, 2009; Zaccaro *et al.*, 2018) cognitive capabilities (Spencer, McClelland and Spencer, 1992; Backus *et al.*, 2010; Wai, 2014) and learning styles (Mainemelis, Boyatzis and Kolb, 2002; Kolb and Kolb, 2005). Others include, "educational achievements, hierarchical position, past career experience, skills and competences,…cultural values…career growth expectancies,…achievement expectancies, and work-related expectancies" (Carbery and Garavan, 2011, pp. 28–34).

2. **Subjective norms**. This denotes perceived peer pressures to participate or not. For example, a characteristic of technical fields is the despise of social skills training as right-brain skills and an emphasis on learning technical skills as the premium towards performance (Stoller, 2009;

Perry *et al.*, 2017). Other determinants include; "development norms, perceptions of the transfer environment, contribution expectations of the organisational culture…achievement norms…and staffing norms" (Carbery and Garavan, 2011, pp. 34–37).

3. **Perceived behaviour control**. The perception of or situations in which the person may desire to participate in development activities but is held back by limitations such as resources. Other elements include self-efficacy beliefs and leader efficacy, confidence to use particular learning strategies and organisational constraints such as organisational culture, economic environment, and how much it encourages the learning of leadership (Hannah *et al.*, 2008). It also includes the HR systems, processes and practices across the employee lifecycle and how they integrate and encourage learning (Scandura and Lankau, 1996; Fairhurst, 2009; Reichard and Johnson, 2011). It also includes "self-directness and confidence to use personal learning strategies" (Carbery and Garavan, 2011, p. 38).

4. **Intention**. The ambition to engage in leader development practices describes a person's willingness to exert effort in learning leadership. It includes the desire to "participate in future activities;…felt responsibility—[the sense of obligation to participate]…and self-prediction—the expectation that one will participate in future [leader] development activities" (Carbery and Garavan, 2011, p. 40). This is sometimes demonstrated by signing up for training or taking steps to find a mentor or coach.

5. **Behaviour**. The actual behaviour of participating in leader development activities including the intensity of exposure to leader development practices such as formal leadership training, self-study, coaching and mentorship programmes, action-learning projects, 360-degree feedback, cross-disciplinary interactions, and informal hands on supervisory experience.

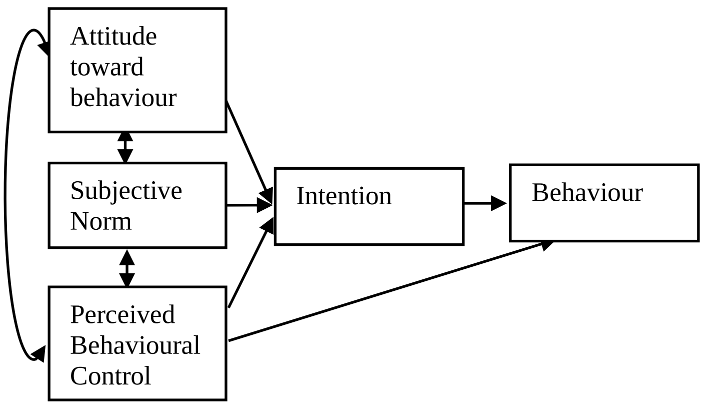

Figure 2.1 Theory of Planned Behavior Model
Source: Ajzen (1991, p. 182)

2.11.6 Self-efficacy theory

Self-efficacy theory suggests that those natural scientists who see themselves as leaders or capable of taking on leadership roles and positions will be more eager to participate in leader development pursuits and therefore demonstrate greater resilience in adopting and benefiting from activities expected to develop leadership skills. Bandura (1977, p. 191) explained that, “expectations of personal efficacy determine whether coping behaviour will be initiated, how much effort will be expended, and how long it will be sustained in the face of obstacles and aversive experiences.” Similarly, Liu *et al*. (2019) emphasise that even taking on leadership roles and effective performance in the same way, is influenced by self-efficacy. “Clearly, people who believe in themselves and their abilities are better suited to lead than those who doubt their leadership abilities” (Liu *et al.*, 2019, p. 1229). Moreover, extant literature suggests that the leaders’ self-view, self-efficacy along with the belief that they can learn leadership (developmental readiness and learning orientation) have an impact on their engagement with leader development activities such as training or mentorship and their ability to grow leadership knowledge, skills and abilities (Dweck, 1986; Hayamizu and Weiner, 1991; Avolio and Hannah, 2008, 2020; Hannah *et al.*, 2008; Lester *et al.*, 2011). Otherwise, why would one be motivated to learn what they believe they cannot learn? In fact, in an empirical, quasi-longitudinal study, Reichard and colleagues demonstrated that leaders who believed more in their ability to learn leadership intended to participate in leader development to augment past leader development efforts and that, “Intentions to develop as a leader, in turn, predicts actual implementation of leader development behaviours 1 month later” (Reichard *et al.*, 2017, p. 137).

Additionally, Ajzen’s (1991) TPB guides that the intention to carry out any behaviour—for example, participating in leadership training—is affected by an individual’s attitude and perceived behavioural control. Furthermore, even though they were studying adolescents, Murphy and colleagues observed that those with higher leader self-efficacy could easily self-identify as leaders and demonstrate typical leadership behaviour (Murphy, 2011; Murphy and Johnson, 2011). In addition, to emphasise the importance of leader characteristics, Murphy and Ensher (1999, pp. 1386–1387) highlight that leader characteristics like gender, optimism, previous job experience, and self-efficacy were predictors of the quality of the leader-subordinate relationships and performance appraisals. Moreover, Tajfel and Turner’s (1986) social identity theory posits that individuals often classify themselves in social categories such as religious affiliation or social strata, a process mediated by self-efficacy (Ashforth and Mael, 1989; Hogg, 2001; Tajfel and Turner, 2004). As a result, natural scientist personnel who self-identify more as leaders and less as technical professionals, which is often not the case, would more likely exhibit archetypical leadership characteristics (Stoller, 2009; Colcleugh, 2013; Perry *et al.*, 2017).

For these reasons, the conceptual framework adopted for this study synthesises guidance from the TPB, implicit leadership theory and self-efficacy theory to include three concepts—*leader characteristics, attitudes and perceived behaviour control*. Leader characteristics may include such constructs as self-image, family backgrounds, birth order, perceptions on learning, beliefs about natural scientist's place in society, perceived cognitive capacity and others (Kaagan, 1998; Mumford, Zaccaro, *et al.*, 2000; Hall, 2004; Zaccaro, 2007; Baker, 2014; Zaccaro *et al.*, 2018).

2.11.7 Conceptual framework of this study

Leader development is a function of many interrelated influences on the individual's intrapersonal and interpersonal characteristics as well as contextual influences in the organisation, industry or field (Day *et al.*, 2014). Intrapersonal characteristics that can predict leader development include personality (Mumford, Zaccaro, *et al.*, 2000), self-efficacy and leader efficacy (Hannah *et al.*, 2008), cognitive capabilities (Spencer, McClelland and Spencer, 1992) and learning styles (Kolb, 1984) among others. Interpersonal characteristics include "social interactions that occur within the leadership process" (Day *et al.*, 2014, p. 68), for example, social capital and effective working relationships (Bilhuber Galli and Müller-Stewens, 2012). Contextual influences include the organisational culture, climate, economic environment, and how much it encourages the learning of leadership. For example, stress, hardships and challenging work have been found to increase the opportunity to grow in leadership, even though experienced leaders would have learned how to manage stress and thereby benefit less from such experiences (Murphy and Ensher, 1999; Liu *et al.*, 2020). Context also includes the HR systems, processes and practices and how they integrate and encourage learning (Fairhurst, 2009; Reichard and Johnson, 2011).

Eisenhart (1991, p. 205) defined a theoretical framework as "a structure that guides research by relying on a formal theory [or theories]…constructed by using an established, coherent explanation of certain phenomena and relationships." As discussed earlier, existing theories were individually insufficient to tackle the research questions, therefore, requiring that this study adopts a conceptual framework that threads together the relevant theories (Collins and Stockton, 2018). Moreover, some scholars warn of problems with over-relying on existing theory such as confirmation bias and suggest that a conceptual framework is useful in using study data to develop new theory (Adom, Hussein and Adu-Agyem, 2018; Collins and Stockton, 2018). That notwithstanding, as Grant and Osanloo (2014) implore, given the need to clearly outline a theoretical framework as a blueprint, this study explicitly relies on the theories of planned behaviour, social identity, and expert leadership.

Grant and Osanloo (2014, p. 16) differentiate the theoretical and conceptual framework by asserting that "a theoretical framework is derived from an existing theory (or theories) in the literature that has already been tested and validated by others and is considered a generally acceptable theory in the scholarly literature." On the other hand, a conceptual framework is explained as a researcher's construction of how the study would address the research problem, and justification of the constructs, concepts and principles involved and how they relate with each other within the overarching theoretical underpinnings (Eisenhart, 1991; Grant and Osanloo, 2014; Adom, Hussein and Adu-Agyem, 2018; Collins and Stockton, 2018). Because this study integrates a deductive and inductive approach (Saunders *et al.*, 2016), it uses existing theories outlined in section 2.11 to guide the study and the conceptual framework as a scaffolding needed to answer the research questions and develop a new model of leader development appropriate to natural scientist settings.

In the conceptual framework for this study, exposure to leader development activities mediates the skills, attitudes, self-efficacy, confidence and behaviours associated with leadership at both the intrapersonal and interpersonal levels. Given the complexity and multiplicity of factors associated with leader development, the conceptual framework (see Figure 2.3 below), guided the study to limit itself to the relationship between participation in leader development practices and the mediating constructs, during the qualitative phase. The quantitative phase investigated the association amongst exposure levels to leader development and leadership effectiveness. Leadership effectiveness was measured by an index based on a self-reported rating against the skills, behaviours, and competences associated with leadership success (Madanchian *et al.*, 2017). The leader development approaches were from the literature and validated during the qualitative phase of the study.

In this framework, exposure to leader development approaches impacts on the skills, attitudes, self-efficacy, confidence and behaviours associated with leadership effectiveness at both the intrapersonal and interpersonal levels (Lacerenza *et al.*, 2017). Exposure to leader development also impacts on how leaders learn and the capabilities they develop, hence the inclusion of various levels of exposure in the conceptual framework. Furthermore, examining the influence of contextual factors enables the explaining of the role and nature of the relationship between levels of exposure to various leader development approaches and reported leadership effectiveness. This is because context is important as highlighted by the preceding review of the literature. Moreover, as the literature review highlighted, context affects both the leadership effectiveness — since exogenous circumstances can attenuate a leader's performance—and extent of exposure to leader development approaches — since HR practices, organisational culture and industry norms attached to leader development can affect how leaders learn or emerge.

Leadership effectiveness was represented by self-reported ratings on scale items measuring skills, behaviours, and competences associated with integrity and honesty, strategic thinking, communication skills, self-awareness, talent management, role ownership, interpersonal relations, problem solving, decision making, innovation and creativity. These were identified based on the review of leadership effectiveness measurement tools (Madanchian *et al.*, 2017) and the literature highlighted in section 2.3 above.

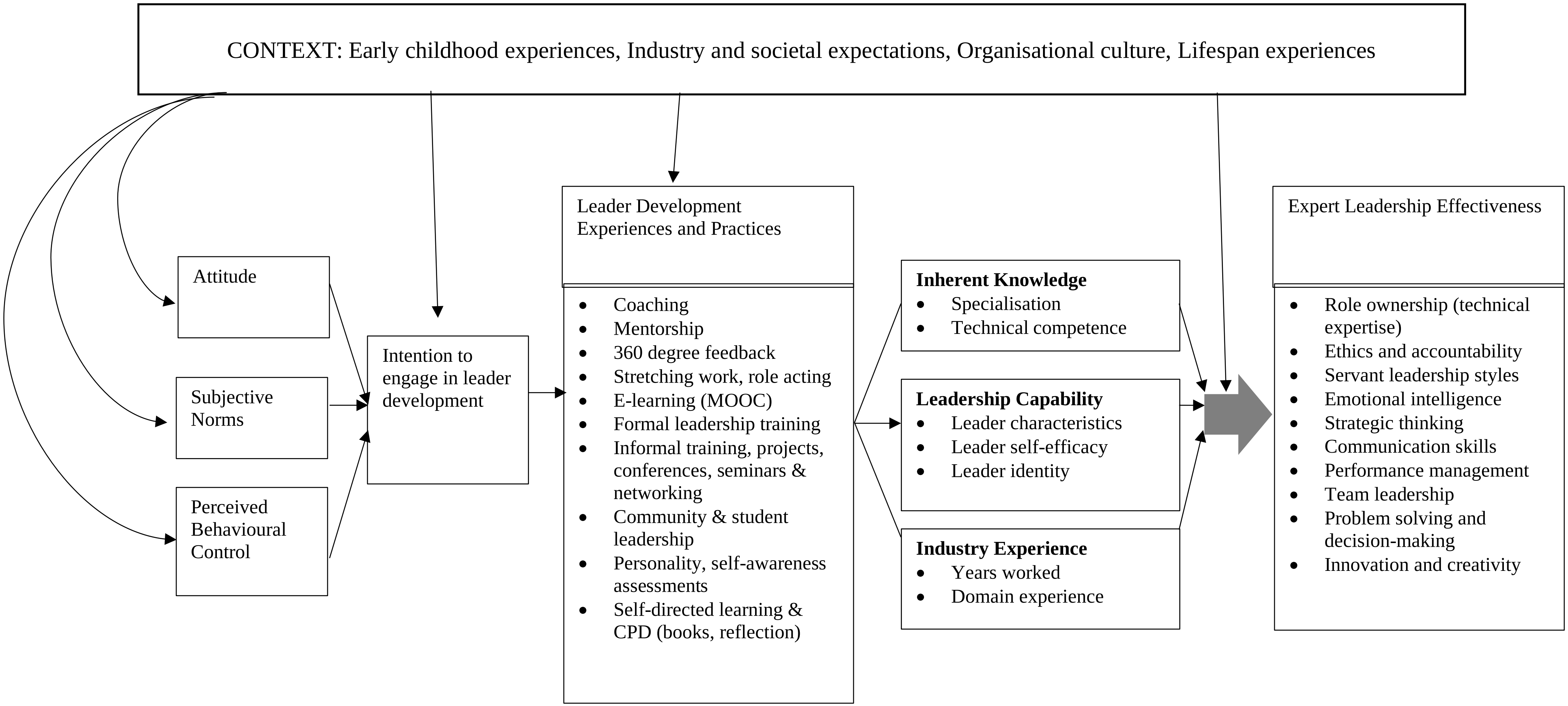

Figure 2.2 Theoretical and Conceptual Framework: Adapted from Ajzen (1991); Goodall (2012); Epitropaki *et al*., 2013; Goodall and Bäker (2015); Liu *et al.* (2020)

2.12 Chapter conclusion

This chapter reviewed extant literature on leader development and examined the major leadership theories and learning theories and the implications for leader development. The review used a systematic search process and included relevant literature using databases covering social and natural sciences literature. Sections 2.3 looked at the definition of leadership and its framing power in directing the theory adapted and study methodology. It also looked at the historical perspective on our understanding of leadership to-date and discussed the evolution and emergence of modern leadership theories, looking at their pros and cons.

Section 2.4 discussed leader effectiveness and the challenge of measuring a phenomenon as complex as leadership. It outlined the different schools of thought on what makes up leadership effectiveness, how to measure it, and concluded with a pragmatic approach to proximation of leadership effectiveness within the natural sciences and expert fields, based on the behaviours and competences the literature suggests to be critical for leadership among scientists. These formed the basis of developing and piloting the study questionnaire as discussed in chapter 3.

Sections 2.5 to 2.7 discussed what the literature highlights as guiding theories and frameworks for learning, adapting new behaviours and consequently leader development. It was observed that according to the existing literature, there is a multiplicity of leader development approaches but little has been studied about their relative effectiveness or the appropriateness of these approaches to specific contexts such as natural sciences. Moreover, even where some literature exists, it was based on studies undertaken in the developed world, and in narrow niche communities such as military settings or nursing units. Where larger populations were studied, again, the context was limited to public sector organisations, moreover in the developed world setting where governance systems are uniquely different from an African setting. In some cases, there were methodological gaps, as most studies in leader development applied a quantitative approach—a bias that dominates existing leadership research. Section 2.7 examines what is known about various leader development approaches and activities which then informs the conceptual framework in section 2.11 and the study questionnaire.

Sections 2.8 and 2.9 discussed leader development within the specific context of natural sciences with the lens on the existing gaps in the literature related to how leader development has been studied within this unique context. It looks at the value of mixed-methods research and comparative studies as a methodological remedy to the identified gaps. Section 2.10 then summarises the identified gaps in the literature and the basis for the research questions that guided this study. Section 2.11 discussed promising theories that provided guidance on leader development and leadership effectiveness and identified the expert theory of leadership and the TPB as central in providing the framework needed for studying the relationship between context, leader development approaches and leadership effectiveness. Other theories that explain this relationship in some way included the social identity theory, social learning theory, experiential learning theory, and implicit leadership theory. The section also highlights the insufficiency of any of the theories in framing the current study. Section 2.11 then synthesises the guidance provided by all these relevant theories into a conceptual framework that aligns with the research questions and the identified gaps in the literature.

CHAPTER THREE — METHODOLOGY

3.1 Introduction

This chapter outlines the philosophical orientation, study population, ethical considerations, data collection, and analysis procedures used. This mixed-methods comparative study aimed to examine the leader development experiences of natural scientists holding leadership positions in two government agencies in Uganda. The study also aimed to identify leader development approaches that are associated with higher levels of leadership effectiveness among leaders in natural science settings. As explained in chapter 2, section 2.4, and in section 3.8.3 of this chapter, leadership effectiveness is defined as demonstrating proficiency in ten critical leadership capabilities. These include role ownership, emotional intelligence, servant leadership, strategic thinking, ethics and accountability, performance management, decision making and problem solving, team leadership, communication skills, innovation and creativity.

3.2 Research philosophy and approach

In emphasising the significance of a researcher's paradigm, Guba and Lincoln (1994, p. 105) insist that "Questions of method are secondary to questions of paradigm." The researcher's philosophy has a significant bearing on the choices made, how the study is framed, and how findings are interpreted (Johnson and Clark, 2006; Saunders *et al*., 2016). In leadership studies, Bogenschneider (2016, p. 24) argues that "there are many competing approaches to knowing things," and therefore, an explicit epistemology is needed. Saunders *et al.* (2016, p. 119) define epistemology as "the researcher's view regarding what constitutes acceptable knowledge," and ontology as "the researcher's view of the nature of reality or being" (Saunders *et al.*, 2016, p. 119). Bogenschneider (2016) argues that because leadership studies is a nascent field, the scientific methodology of causation and inference rather than descriptive observation is necessary to increase our understanding of leadership. He suggests that this "scientific nature of study" (Bogenschneider, 2016, pp. 24–25) is not common within leadership studies because the incentives to propose a new theory of leadership are stronger than to test or falsify existing ones. He adds that the lack of a definitive leadership epistemology means each researcher will approach leadership based on their backgrounds and disciplines (Bogenschneider, 2016).

However, other scholars argue that it is impossible to expunge the researcher's background in the establishment of their epistemology because the way an individual views the world determines their philosophy (Saunders *et al.*, 2016, pp. 107–120). Moreover, other paradigms such as constructivism, interpretivism and critical realism are legitimately scientific (Kempster, 2015; Fletcher, 2017).

Moreover, as Bogenschneider (2016, p. 28) himself admits, science expects a "systematisation of theories and not mathematical proofs," something achievable outside of post-positivism.

This positivist view of the supremacy of the quantitative approach to inquiry has dominated most of the leadership research due to the influence of "fields of industrial/organisational psychology, social psychology and organisational behaviour" (Parry *et al.*, 2014, p. 134; Ashford and Sitkin, 2019, p. 455). Despite the reluctance by mainstream academic leadership literature to embrace qualitative research (Parry *et al.*, 2014, p. 135), as some have argued, qualitative methods (for example, those using grounded theory or content analysis) are robust enough and do not necessarily have to be buttressed with quantitative methods (Conger, 1998; Suddaby, 2006; Kempster and Parry, 2011). Moreover, the nature of leadership phenomena and its context is so complex that truly understanding it requires the 'lantern' approach of illumination among the experts who understand their setting (qualitative research) much more than the 'window' approach of observations through filters of positivism into a decontextualised 'world' the researcher does not belong to (Conger, 1998; Parry *et al.*, 2014).

Positivism argues that there exists an external reality that can be studied objectively through scientific methods (Suddaby, 2006; Parry *et al.*, 2014). The positivist ontology is realist, and epistemology is objectivist (Guba, 1990, p. 20). Post-positivism expounds on this by way of a critical realism ontology and an epistemology of modified objectivism. Critical realism acknowledges the limitations of humans to decode reality fully. Modified objectivism acknowledges the bias that researchers bring to the inquiry process by confounding the reality with their value system, beliefs and experiences, requiring mediation through peer-reviews, ethical reviews and methodological rigours such as triangulation (Guba, 1990, pp. 20–21; Denzin, 2010).

The study ontology lies on a continuum between objectivism and subjectivism, while the epistemological orientation inclines towards post-positivism than pure constructivism paradigms. This is manifested in the three-phased approach to this study. First, an exploratory, inductive approach was taken using in-depth interviews, particularly exploring contextual experiences of leader development among natural scientists from a constructivism lens. This was necessary since little was known about what Ugandan leaders in technical fields, such as natural scientists, perceive to be the unique learning needs and leadership development approaches appropriate to their context (Gifford and Finney, 2011; Nakanjako *et al.*, 2015; Perry *et al.*, 2017; Agyepong *et al.*, 2018; Jain and Koratkar, 2019; Baas, Dewhurst and Peyre, 2020). It was hoped, this would enable the understanding of why specific leader development approaches are undertaken and, by so doing, develop a theory around the nature of leadership development activities that are prevalent, acceptable, expected and considered effective in nurturing leadership effectiveness within this context. The second part of the study was deductive in approach—examining the relationship between exposure to the prevalent leader development activities and self-reported leadership effectiveness. In defining and measuring leadership effectiveness and assessing the association between leader development experiences and leadership effectiveness, comparing distinctive case study groups, a post-positivist lens was used. The third phase used a constructivism lens through the Focus Group Discussions method to explore meanings natural scientists attach to the results of the second phase.

The blend of paradigms, as evidenced by choice of the mixed method, was particularly necessary to ensure both research rigour and practical relevance in the study context (Diesing, 1966; Blumenthal *et al.*, 2012; Ma, 2012). The study research philosophy may, therefore, be construed as pragmatism. Building on the work of John Dewey, Morgan (2014) conjectures that pragmatism as a paradigm has much to offer social research and goes beyond the practicalities of problem-solving and the use of mixed-methods research. Morgan (2014) surmises that pragmatism sidesteps the *caricaturism* of the traditional paradigms (such as linking qualitative to constructionism and quantitative to post-positivism) and "disrupt[s] the reliance on a metaphysical version of the philosophy of knowledge as a lens for examining social research" (Morgan, 2014, p. 7). The pragmatism paradigm maintains that research is a human experience that integrates the beliefs and actions of the researcher, including choices of how to do research, why such a choice and how to interpret the attendant outcomes (Morgan, 2014). This view that social research should not focus on "commitments to an abstract set of philosophical beliefs" (Denzin, 2010, p. 422), but rather embrace a new paradigm that transcends characterisation based on boundaries along ontology, epistemology, methodological and axiological lines is the emerging fad. It has been questioned by purists who point to "incompatibility and incommensurability" (Denzin, 2010, p. 422; Morgan, 2014).

There has been much debate on the value of each paradigm, particularly the advantages and limits, and consequently, the appropriate strategy for a specific study (Guba, 1990; Guba and Lincoln, 1994; Denzin, 2010; Alexy, 2017). The resolution of these debates is impossible because scholars approach each one with their own paradigm (Alexy, 2017) and what Denzin (2010, p. 422) called the "politics of evidence". Guba, himself a constructivist, explains a paradigm as "a set of beliefs that guides [the researcher's] action," arguing that these can be distinguished by way of ontology, epistemology, and methodology (Guba, 1990, pp. 17-18).

This study takes the constructivist ideal because the reasons why natural scientists adopt particular leader development activities can only be understood from the perspectives, experiences, and meaning that the natural scientists themselves attach to these activities, hence the qualitative approach. On the other hand, as the study looks into the link between these leader development activities and leadership effectiveness, it cannot leave the notion of leadership effectiveness to everyone's own interpretation. Moreover, leadership effectiveness as a construct will be defined and measured differently depending on one's definition of leadership (Oyinlade, 2006; Madanchian *et al.*, 2017). The study used a psychometric tool to measure leadership effectiveness as determined by an index comprising multiple dimensions of leadership behaviours and competences the literature argues are pertinent for leaders to be effective. This aspect of the study, therefore, adopts the post-positivist paradigm and an objectivist ontology.

This philosophical stance is supported by Burgoyne (2009), who argues that critical realism provides insights into leadership development by neither focusing on the extreme approaches of the positivist or the social constructionist approach. Furthermore, in their assessment of methodologies and approaches best suited for studies investigating the intervening step between leadership development and performance, Burgoyne *et al*. (2004) argued that new methodologies are needed and suggested that post-positivism was the most promising.

3.3 Research strategy

The research strategy applied was a case study of two organisations using a mixed-method design research choice. The study involved semi-structured in-depth interviews and a cross-sectional survey to ascertain the prevalence of various leader development practices and their attendant levels of exposure as well as self-reported leadership effectiveness. The analysis techniques provided both descriptive and inferential statistics. Semi-structured focus group discussions were deployed to clarify and give meaning to some of the findings from the quantitative survey. The time horizon for this study was cross-sectional. Although preferred, given the power to explore trends and a dose-response relationship, a longitudinal study was not feasible due to time and resource constraints (Day and Sin, 2011; Day *et al.*, 2014; Goodall and Pogrebna, 2015).

3.4 Research choices, methods and techniques

In this study, qualitative methods were included to understand better the experiences and challenges of leader development in the context of natural scientists in Uganda and explore what leaders in specialised scientific fields find as essential elements within current approaches for leader development and why. This was compared to the experiences of leaders outside natural sciences and what they believe is critical. Primary data was collected and analysed using thematic analysis (Corbin and Strauss, 2008) to understand the context—particularly the factors affecting leader development and leadership effectiveness at the individual level, institutional/industry level and operational level. One case-organisation (MAAIF) represented natural scientist leaders, while the other (URA) represented non-scientist leaders.

A cross-sectional descriptive survey, along with comparative inferential analysis (Babbie, 1990) was deployed for the quantitative aspect of the mixed method choice. The quantitative approach worked to address the weaknesses and limitations of qualitative leadership research mostly associated with low validity and reliability of the generated theory (Bryman, 2004) and the lack of generalisability (Creswell, 2012). The cross-sectional survey assessed the frequency, relevance and exposure levels of the leader development experiences/approaches identified both in the qualitative phase and the literature. These leader development activities/approaches were categorised as independent variables.
The survey also included a self-reported leadership effectiveness assessment in determining the levels of leadership effectiveness through an index—categorised as the dependent variable. The leadership effectiveness index was arrived at through factor analysis of behavioural items delineated from the literature as essential dimensions of leadership (See Chapter 2, section 2.4). Both the qualitative and quantitative study phases were guided by "the same theoretical framework", as advised by Silverman (2013, pp. 137–138) in order to strengthen the triangulation and complementation of methods. For example, both assessed the intention, subjective norms, perceived behavioural control, and attitude, as determinants of participation in leader development activities.

Comparative analysis of the relationship between leadership effectiveness (dependent variable) and levels of retrospective exposure to the leader development approaches (independent variables) provided insight into what approaches work within the natural sciences field. Descriptive and inferential comparative analysis of the same relationship between exposure to leader development activities and leadership effectiveness was undertaken for leaders outside the natural science fields. Statistical significance was tested for the relationship between exposure to different leader development approaches and leadership effectiveness in both groups and the means compared. Observed intriguing differences between the two groups and the extent of the dose-response relationship between the two comparator groups were used, in addition to triangulation with the qualitative results, to develop a framework for designing leader development programmes among natural scientist. The use of mixed-methods emphatically adds value to the understanding of leadership and generation of theories that have both academic and practitioner relevance (Böhme *et al.*, 2012). As Parry *et al.* (2014) advocate, progressive leadership research requires both qualitative and quantitative methods. They write:

> We believe that studies of leadership can progress only by taking both systems of observations into account. Thus, qualitative studies might be used to examine the effect of context on general conclusions flowing from survey studies. Such multi-method approaches may, over time give rise to a richer, and more robust, framework for understanding leadership. We ….provide an impetus for future research, multi-method research, along these lines (Parry *et al.*, 2014, p. 149).

The table below summarises the current study research methodology using the research onion (Saunders *et al*., 2016, p. 108).

Table 3.1 Research design

Onion Layer	**Research Methodology**	**Reason for choice**
Philosophies	A pragmatist blend of post-positivism and constructionism	Researcher's experience & orientation and research questions
Approaches	Inductive & Deductive	The inductive phase enlisted the current leader development practices and why natural scientists prefer them. The deductive approach assessed levels of exposure, effectiveness and the link between activities and effectiveness.
Strategies	Case study, Survey	Two distinct case study organisations offered opportunities to compare groups. Survey provided data for quantifying levels of exposure to leader development activities, and analytics for inference and generalisability in line with a post-positivist stance.
Choices	Mixed Methods	Need for triangulation in case of phase 1 and phase 2 and for qualitative methods to append meaning to findings in phase 3, in line with a constructivist stance.
Time horizons	Cross-sectional	Time constraints did not allow a longitudinal study
Techniques and procedures	• Online face-to-face, semi-structured interviews. • Online survey questionnaire. • Virtual Focus group discussions.	Techniques aligned to choices. Choice of online survey is for practical and cost reasons as well as ethical and safety considerations due to COVID-19 meeting restrictions.

Source: Own

3.5 Target population

The study participants were selected from two government agencies—the Ministry of Agriculture (MAAIF) and the Uganda Revenue Authority (URA). These were selected because they are comparable (both government agencies) and follow a similar governance framework. Additionally, the organisations are different in that MAAIF, by mandate, mostly employs scientists, while URA employs a wide range of disciplines. Furthermore, these fields represent the frontline of Uganda's renaissance, agriculture and taxation for self-financing (World Bank, 2018). For example, in Uganda, agriculture contributes 25.3 per cent to the GDP and employs 85 per cent of the population (Mugagga, Kakooza and Asiimwe, 2018). Based on information from the human resources managers at both case study institutions, and examination of the staffing lists, it was determined that there were just over 350 leadership level positions at URA and 150 positions at MAAIF including attached agencies. Altogether, the target population comprised 500 leaders.

The Ministry of Agriculture is also relevant for this study because agriculture is a significant sector in driving Uganda's growth and poverty reduction (Joughin and Kjær, 2010). It employs 77 per cent of the rural adult population and accounts for roughly 50 per cent of the merchandise exports (Bategeka, Kiiza and Kasirye, 2013). Despite this importance, agriculture has lagged behind industry and the services sector for the past ten years, ostensibly due to institutional weaknesses in the agricultural sector and the leadership of the organisation itself (Bategeka, Kiiza and Kasirye, 2013). The difference in performance levels and backgrounds of the respective leaders make MAAIF and URA expedient cases for the study in a setting where a control case is impractical.

The choice of the two case study approach, as Levy (2008) argues, is because having more than one case "enhances control over extraneous causal influences" (Levy, 2008, p. 7). Moreover, even where the purpose is to decipher a specific case, there are benefits in looking at ancillary cases. As Levy (2008, p. 7) put it, "A compelling explanation of an individual case requires both demonstrating that the hypothesised explanation fits the evidence in the case and that it fits the evidence better than do leading alternative explanations." In this study, MAAIF was the case-organisation while URA played a pseudo 'control' organisation.

3.6 Sample size and participant selection

The relative spread of interview participants and survey respondents is highlighted in the table below.

Table 3.2 Sample size

	Qualitative Phase	Quantitative Phase
	Number of leaders participating in the interviews	Number responding to survey (Survey instrument was sent to all leaders in supervisory positions—150 scientists and 371 non-scientists)
Scientists	N=21	N=118
Non-scientists	N=11	N=103

Different scholars advise various approaches to determine the sample size. However, there remains much confusion due to the multiplicity of factors to consider given diversity of study designs and the balance between the precision of the study and cost (Noordzij *et al.*, 2011; Charan and Biswas, 2013). This is particularly the case because, at study inception, little is known about the population under study. Noordzij *et al*. (2011, p. 323) argue that unlike Randomised Controlled Trials (RCT), exploratory cross-sectional studies, like the current study, where hypothesis testing is not of paramount importance, errors arising from inadequacies in sample size calculations are trivial. Nonetheless, a scientific process informed this study's sample size in order to have sufficient power to detect a difference between case study organisations, and effect sizes between leaders who were highly exposed and those who were lowly exposed to leader development. In so doing, the study could be used for generalisation.

For the qualitative phase, purposing sampling was used. According to Tongco (2007), purposive sampling is appropriate when the researcher needs to obtain information from experts and therefore selects the study participants most likely to possess the knowledge and experiences required to provide the data relevant to answer the research questions. Probability sampling techniques require that each participant have a known and nonzero chance of being chosen, thereby minimising bias (Tongco, 2007; Palinkas *et al.*, 2015; Campbell *et al.*, 2020; Turner, 2020). However, in the case of simple random sampling, the selected participants may not be representative of the population or may not have the necessary depth of experience to authoritatively speak as key informants about the phenomenon under study (Tongco, 2007; Campbell *et al.*, 2020; Turner, 2020). While random sampling would eliminate selection bias, purposive sampling was adopted in order to identify knowledgeable participants, representing different strata of leadership responsibility and typifying the profile of leaders in the case organisations. Tongco (2007) acknowledges that purposive sampling can be riddled with selection bias and informant reliability problems, particularly if the researcher does not follow due process. However, they conclude that "Purposive sampling is a practical and efficient tool when used properly, and can be just as effective as, and even more efficient than, random sampling" (Tongco, 2007, p. 155).

Moreover, purposive sampling increases the trustworthiness of the data by carefully matching the research aims to the sample (Campbell *et al.*, 2020). Accordingly, three strata of interviewees were selected from each organisation—senior leaders (Director and Commissioner level), middle management level leaders, and frontline supervisors. The rationale was to capture perceptions on leader development from all levels of the organisation. Moreover, senior leaders were more likely to have had higher exposure to leader development opportunities. In order to avoid bias where gender influences on leader development are missed, female leaders were encouraged to participate since these are much fewer in the natural sciences fields in Uganda.

For the quantitative phase, a sample size calculator software G*Power 3.1 was used with required significance level p=0.05, desired statistical power level (1-β) at 80%, and the projected effect size (Cohen's d) at 0.3, as guided by Faul *et al.* (2009) These estimations were determined *a priori* based on the pilot testing of the questionnaire with 53 participants and what literature has determined as typical for cross-sectional and case-control studies (Edwardes, 2001; Charan and Biswas, 2013). Additionally, a conservative approach was taken, with the assumption that there would be minimal differences between leadership effectiveness and a considerable variation in the means between MAAIF and URA. The estimated sample size was 139 per case study organisation, with a total of 278 respondents. The minimum required sample for the quantitative research phase would only be reached if the response rate was above 56%, something unlikely considering that the pilot study showed a response rate of 53%. Moreover, the pilot study was more likely to enlist response from the enthusiastic early adopters (Riverola, Dedehayir and Miralles, 2016). Moreover, Crawford and Kelder (2019, p. 141) recommend a bare minimum of 150 responses for an empirical evaluation of leadership scales.

Given the small population of leaders and the context of the study, whereby COVID-19 disruptions to workplaces were expected to contribute to a low response to the survey, a census approach was taken for the quantitative survey. The survey questionnaire was deployed to all staff who occupied a supervisory position at all levels of the organisation via an online SurveyMonkey link. To increase the chances of participants responding to the survey, the Gatekeepers in each organisation were requested to send reminder emails. Additionally, an incentive of leadership e-books downloads after survey completion and the use of personalised emails was added (Kaplowitz, Hadlock and Levine, 2004). For the medical association, the survey link was sent to practising doctors as this too is a leadership position for medical teams (Carsen and Xia, 2006). Determination of respondents who qualified as natural scientists was made through analysis of the respondents' answer to the question "what technical field describes you best?" or if they described themselves as a scientist.

3.6.1 Inclusion and exclusion criteria—qualitative phase

Participants were included among the interviewees if, they accepted to be interviewed and answered "yes" to the statement, "I hereby provide consent to audio-record my interview/focus group discussion." Additionally, participants needed to have been at the organisation for more than two years as this was deemed to be sufficient time for them to understand the history of leader development efforts in the organisation and to have accumulated tacit knowledge in their field and context. Leaders responsible for the design and evaluation of leader development interventions were also sought out owing to their expert understanding of the organisational and industry context. A representation of various natural science fields such as engineering, medicine, agronomy, biochemistry, agriculture, food science, zoology, computer science, were included. Perry *et al*. (2017) have argued that the leadership skills required for physicians are different at each stage of their career (also see Mumford, Campion and Morgeson, 2007) and that efforts should be made to build skills at the start of the pipeline. Consequently, efforts were made to include leaders at different levels of management responsibility so as to gain perspectives from those at the frontline, middle managers and senior leaders.

3.7 Data collection

Among the various data collection methods used in qualitative research, interviewing is most effective as it provides a wholesome spectrum of processes leading to leader development (Conger, 1998; Bryman, 2004; Parry *et al.*, 2014). Therefore, in this study, in-depth key informant interviews were used. Focus Group Discussions (FGD) were added to the methods for triangulation purposes and to amplify the depth of meaning for the emerging conceptual framework and model, in ways to diminish the limitations of the individual interview.

3.7.1 Qualitative research — key informant and in-depth interviews

Data was collected by way of semi-structured interviews with leaders in both study groups. The interview protocol was pilot-tested before the interviews were done on March 24, 2020 among two leaders in the Learning & Development (HR) team from each of the case study organisation. Feedback obtained showed there were no ambiguous questions. Consequently, none was removed. However, the respondents advised that the interviewer must be mindful of the limited time that targeted leaders have and therefore focus on the critical questions within each theme since most of the respondents are busy and would be expected to want to spend no more than an hour in the interviews. Themes and discussion questions were informed by a comprehensive literature review and the theoretical and conceptual frameworks. Participation was voluntary, and no monetary compensation for time spent was provided to the study respondents. Following the pre-test, interviews were conducted between May and

December 2020 and were between 36 minutes and 108 minutes long. Whereas 25 leaders were targeted for interview among the scientist and 15 among the non-scientist groups, only 20 and 11 were interviewed, respectively. After numerous reschedules for the leaders that could not make it and realising that there was a degree of saturation for every additional interview, no further interviews were scheduled (Corbin and Strauss, 2008). To ensure consistency, dependability and conformability, interviews and FGDs were conducted/moderated by the same person (the researcher) using a semi-structured interview schedule (See Appendix 1).

3.7.2 Qualitative research — focus group discussions

FGDs were held—one for each case organisation. A detailed guide was developed with questions formulated per the study objectives and research questions and about the findings from the cross-sectional survey. This guide was pilot-tested before the FGDs on March 19th, 2021. Homogeneity of participants in an FGD was ensured through responsibility and age matching. This ensured the active participation of all respondents in the group. FGDs had six and eight participants for URA and MAAIF respectively and were conducted via Zoom conferencing due to COVID-19 protocols. Participants were encouraged to secure a quiet environment to avoid disruptions. The FGDs lasted just under an hour to minimise participant fatigue. The proceedings were digitally recorded upon explicit consent of the participants. The FGDs were conducted on March 22nd, 2021 for URA and March 31st, 2021 for MAAIF.

3.7.3 Quantitative research — survey

In a similar study, Brungardt (2011) used a survey based on self-reported leadership effectiveness. Though this predisposes it to social disability bias (Grimm, 2010b), this limitation was attenuated by use of a pilot-tested validated instrument for measuring leadership effectiveness and by enabling the randomisation of scale items through the functionality of SurveyMonkey. Given that the study participants had ready access to the internet and to reduce the cost of data collection, data entry and analysis, data collection was via an online *SurveyMonkey* self-administered questionnaire (https://www.surveymonkey.com/r/LDS-MAAIF and https://www.surveymonkey.com/r/LDS-URA).

The survey for the current study was deployed on September 22nd, 2020, and left open for respondents until December 15th, 2020. Whereas it had been anticipated that the survey would be deployed earlier, the delay in conducting in-depth interviews (Phase 1) as a result of the restrictions on movement and face-to-face meetings meant that the quantitative phase would be delayed. Moreover, in the early days of the COVID-19 pandemic, the disruptions at the study sites were considerable, with the case organisations being classified as essential services. This meant that potential respondents would be either unavailable or mentally distressed in ways that completing the survey could add unnecessary stress. Ethical considerations necessitated postponing the survey to a later date. The month of September, 2020 was deemed an appropriate time because by then, workplaces had found coping mechanisms with the *new normal*, the pandemic in Uganda was under control, and both case-organisations were commencing a new financial year, a time when the amount of work in government agencies is low and, most leaders are not too busy to engage.

3.8 Study variables

As highlighted in the theoretical and conceptual frameworks (see Chapter 2, section 2.11), leadership and leader development among experts such as natural scientists is intermediated by industry experience and inherent knowledge (Goodall, 2012, p. 6). It is also a function of attitude, perceived behavioural control, subjective norms and intentions (Ajzen, 1991). Within the boundaries provided by the conceptual framework, commensurate with the research questions, the following variables and constructs were operationalised as follows:

3.8.1 Leader development

The theory underpinning this study requires that specific behaviour be explicitly defined (Fishbein and Ajzen, 2011, p. 450). In this study, the behaviour was defined as the action of participating in leader development activities. In the qualitative phase, the experience of leader development was studied. In the quantitative phase, the intensity of exposure to leader development practices such as formal leadership training, self-study, coaching and mentorship programmes, action-learning projects, 360-degree feedback, cross-disciplinary interactions, and informal hands-on supervisory experience was assessed.

According to Liu *et al.* (2020, p. 15), leader development comprises any activity across one's lifespan that can be used to "gain, hone, and learn leadership skills." This perspective acknowledges the wide-ranging nature of activities at the individual, societal, workplace and daily-life that can contribute to getting better at leadership (Day, 2000; Burgoyne *et al.*, 2004; Lee and Hur, 2015; Liu *et al.*, 2020). For the purposes of operationalising this concept, leader development was broadly defined in the exploratory phase of the study, illuminating all the experiences of leader development from the participant's perspective. Why they believe such activities are important for leader development in their context was also explored. This constructionist approach was in line with the study objectives and allowed the exploration of a context not well understood. Moreover, as Fishbein and Ajzen (2011) advise, the exploratory approach enables the contextual understanding of behavioural, normative and control beliefs and informed the design of questionnaire items assessing these in the quantitative phase of the study (Ajzen, 1991; Carbery and Garavan, 2011).

To operationalise leader development as a construct for the quantitative phase of the study, specific leader development activities were included as variables. Only those activities emanating from the interview phase as relevant and critical, and those that the literature review identified to be impactful were included for pilot testing. Overall, 35 leader development activities were included initially. After pilot testing, the activities were reduced to ten through a process described in section 3.8.3 below.

Following the guidelines by Fishbein and Ajzen (2011, p. 450) to define behaviour "in terms of its target, action, context, and time elements," leader development was defined as participation in one of the ten leader development activities occasionally, moderately or substantially as the main growth activity. Participants were able to select the extent/frequency of participation in each activity using a 5-point Likert scale outlining participation levels (see Appendix 4 for questionnaire). Moreover, the use of the five point as opposed to the seven point Likert scales is associated with shorter completion time and can, therefore, improve response rates (De Bruijne and Wijnant, 2014). The exposure levels and nature of the activities were guided by the literature and the phase 1 exploratory study and the goal to balance between capturing as many exposures as possible and avoiding recall bias (Raphael, 1987). Most social science and natural sciences research limit the length of recall in retrospective studies to a year, but as Kjellsson *et al.* (2014, p. 45) suggest, "appropriate length of the recall period depends on the intended objectives," mediating between capturing as much data as possible and reducing potential bias. This study did not limit the recall period to capture a wide-ranging exposure to developmental activities and because development is cumulative (Mumford, Campion and Morgeson, 2007; Liu *et al.*, 2020). Moreover, the same period was defined for both natural scientist and non-scientists, thereby reducing the threat to internal validity as would have been in a case-control design (Hassan, 2006).

Ajzen and Fishbein (1980) advise that once the study has multiple behaviours, an index summating the different activities can be used to represent the behaviour under consideration. However, a leader development index was not developed as a composite from the combined ten leader development activities because the 5-point Likert scale presented ordinal data with intervals outlined as (1) Not participated in this at all (2) Rarely participated (3) Occasionally participated (4) Moderately a feature of my development and (5) Primary activity for my development. A composite index would erroneously include the 'Not participated in this at all.' Furthermore, the relative relevance of the leader development activities signifies that a composite index that measures overall level of exposure would disregard the weighting of different activities. Maintaining the analysis of exposure at the level of each of the 10 learning strategies/activities, exposure to leader development was, therefore, classified and categorised into 'No exposure' (1)', 'Low Exposure (2-3)' and 'High Exposure (4-5).' Based on this categorisation, various exposure levels were then used to assess the relationship between exposure and leadership effectiveness. On the other hand, the classification of leadership effectiveness emanated from dichotomising the data using the distribution approach which, as De Vaus (2002, pp. 165–166) advises, has the benefit of allowing "the data to define what is low, medium or high" instead of an arbitrary classification.

3.8.2 Determinants of leader development

Building on Ajzen's (1991) work, Carbery and Garavan (2011) have conceptualised participation in leader development activities. Although they limit their leader development activities to formal training, they suggest several factors that "influence both intention to participate and actual participation behaviour," (Carbery and Garavan, 2011, p. 14). These factors and the interconnectedness between them demonstrates the compelling nature of the context in influencing leader development (Oc, 2018; Liu *et al.*, 2020). These factors guided interview schedule design and the development of scale items to measure each of the major constructs in the TPB theory, for the quantitative phase. These determinants are outlined for each of the four constructs in the theory as highlighted in chapter 2, section 2.11

3.8.3 Leadership effectiveness

Madanchian *et al.* (2017, p. 1050) explain that "leader effectiveness is the ability of the leader to effectively influence followers and other organisational stakeholders to complete the goals of the organisation." They argue that how this is measured will vary depending on the industry, the researcher's epistemology and how they define leadership among other factors (Oyinlade, 2006; Yukl, 2008; Hassan *et al.*, 2013). As discussed in chapter 2 (see section 2.4), this study defined leadership effectiveness along ten dimensions as was delineated in the literature as relevant for the leader in natural science contexts—blending the behavioural, competence and contextual models. These dimensions included; role ownership, emotional intelligence, servant leadership, strategic thinking, ethics and accountability, performance management, decision making and problem solving, team leadership, communication skills, innovation and creativity.

Six scale items were developed for each of the ten dimensions, building on the researcher's experiences as a leadership coach, literature review and field expert input (Crawford and Kelder, 2019). The resultant questionnaire was pilot tested and where reliability could be improved this was achieved by dropping specific items that were found to lower Cronbach's Alpha below 0.6 (Gliem and Gliem, 2003). Despite the limitations of the Cronbach's Alpha approach, it was adopted for this purpose due to its widespread use and acceptance by top journals (Sijtsma, 2008).

3.9 Pre-testing the tools

A research instrument's reliability and validity significantly affect the perceived quality social scientists put on any research. Yet, many instruments measuring leadership effectiveness have been questioned (Crawford and Kelder, 2019). Inadequacies in the survey instrument are difficult to compensate for in data collection or analysis, necessitating good questionnaire design and pilot testing (Lietz, 2010; Agarwal, 2011; Song, Son and Oh, 2015). This study, therefore, developed and pilot-tested a questionnaire to measure constructs aligned to leadership effectiveness and determinants of leader development in order to minimise measurement error. These constructs represented ten dimensions as gleaned from the literature (See Chapter 2, Section 2.4). Seven respondents provided feedback on their experiences, completing the survey while overall 53 leaders participated in the pre-testing. This, along with the feedback from an expert panel, was used to revise the questionnaire as outlined in 3.8.3 below. The section that follows describes the process followed for pilot testing and revision.

3.9.1 Face and content validity

The study instruments were reviewed by both the Uganda Christian University (UCU) REC and the UKZN HSSREC institutional review boards as part of the ethical review processes. The UCU REC approved the study on 17th December 2019 while the UKZN HSSREC approved the study on 16th January 2020. The survey pre-test was conducted between March 23rd, 2020 and May 30th, 2020, whereby a survey link was sent out to randomly selected leaders at both participating organisations through the gatekeepers. Only 53 leaders participated in the pilot testing. Additionally, during this period, a panel of six expert specialists in leadership development within the context of natural sciences was mobilised to establish face and content validity. Beyond participating in pilot-testing the survey, they also provided insightful feedback on how to improve its face and content validity. The panel included two deans from two universities in Uganda, one from the School of Health Sciences and the other from the School of Engineering. Other panellists included the Head of Research at a leading health organisation, a senior consultant for the Uganda Ministry of Water and Environment, and the heads of learning and development at the two case study organisations. Each specialist evaluated the instrument for face and content validity and provided comments for improvement. There were no concerns on content validity but minor concerns on face validity, mostly related to unnecessary inclusion of a wide range of leader development practices that are not widely in practice and presumed less important, at the expense of making the instrument long and laborious. Experts recommended reducing the length of the questionnaire.

3.9.2 The reliability testing

The survey questionnaire was sent to 50 randomly selected respondents in each of the two case study organisations. Fifty-three leaders responded to the pilot survey. Reliability of the instrument was then tested through factor analysis of the dimensions measuring leadership effectiveness and the determinants of leader development behaviour. To diminish the need for a large sample size, Exploratory Factor Analysis using variables showing high communalities was conducted using principle axis factoring analysis (Pearson and Mundform, 2010). This was per the guidelines provided by Stevens (2002, p. 395) where he suggests that for small samples with any n<150, "four or more variables with loadings of 0.6 […] or three or more variables with loadings of 0.8," would depict factor reliability. Factor analysis was used to establish the internal consistency of items and discriminant validity across constructs (Fishbein and Ajzen, 2011). Furthermore, Crawford and Kelder (2019) recommend the reporting of Cronbach's Alpha and any other alternative reliability measure (Sijtsma, 2008). Tables 3.3 and 3.4 below outline the Cronbach's Alpha for leadership effectiveness and determinants of leader development behaviour, respectively.

Table 3.3 Cronbach's Alpha for dimensions of leadership effectiveness

Variable (Dimension of Leadership Effectiveness)	Cronbach's Alpha with five items	Cronbach's Alpha with well-loading items only
Role Ownership	0.67	0.73
Emotional Intelligence	0.71	None deleted
Servant Leadership	0.87	None deleted
Strategic Thinking	0.62	0.67
Ethics & Accountability	0.83	None deleted
Performance Management	0.77	None deleted
Decision making and Problem Solving	0.78	None deleted
Team Leadership	0.83	None deleted
Communication Skills	0.70	None deleted
Innovation & Creativity	0.70	None deleted

Table 3.4 Cronbach's Alpha for determinants of leader development behaviour

Variable (Determinants of behaviour)	Cronbach's Alpha with all items	Cronbach's Alpha with well-loading items only
Attitude	0.76	None deleted. Some items reversed
Outcome Evaluation	0.75	None deleted
Subjective Norm	0.81	None deleted
Perceived Behaviour Control—Self-Efficacy	0.60	0.63
Intention	0.77	None deleted

The few constructs whose Cronbach's Alpha was below the acceptable 0.7 even after dropping the items with poor factor loading were maintained because they still were above the questionable but generally acceptable 0.6 (Ursachi, Horodnic and Zait, 2015; Taber, 2018). Moreover, given the small sample for the pilot study, Cronbach's Alpha was expected to improve with a larger sample size (Stevens, 2002; Gliem and Gliem, 2003; Pearson and Mundform, 2010; Charan and Biswas, 2013; Crawford and Kelder, 2019).

3.9.3 Questionnaire revision

Questionnaire pre-testing is essential in determining the clarity of questions, appropriateness of sections and reliability and validity of the study (Presser *et al.*, 2004; Grimm, 2010a). It strengthens the rigour of the study once the feedback is used to improve question-wording, scale wording and to maintain only the items that measure what they purport to measure (Collins, 2003; Presser *et al.*, 2004; Bolarinwa, 2015). For example, feedback from the pilot testing showed that respondents found the scale wording concerning frequency of participation in leader development confusing. The scale, which assessed exposure to leader development activities included wording such as 'occasionally', 'frequently' and 'very frequently', which meant different things to different people, thereby reducing clarity and reliability. This was improved by defining the leader development activities more broadly, including the typical frequencies of exposure. Furthermore, feedback suggested the questionnaire needed shortening to improve response rates and reduce respondent's exhaustion. Items that were not contributing significantly in measuring the purported construct for leadership effectiveness or in measuring determinants of participation in leader development activities were dropped thereby reducing the length of the questionnaire and increasing the instrument reliability. To improve questionnaire flow and to reduce the possibility of respondents confusing the section on exposure to leader development activities with the section on relevance of the same leader development activities, these two sections were separated by a section on leadership effectiveness and determinants of leader development behaviour.

3.9.3.1 Questionnaire length

Completion rates were reported to be 58 per cent by SurveyMonkey software. This necessitated reducing the number of questions and items. The questionnaire had four sections, and missing data in the pilot test showed that respondents who discontinued completion of the questionnaire dropped out in section 2, which had a long list of possible activities for leader development. This was consistent with the feedback obtained from some of the respondents. As one respondent put it, "The questionnaire is too long; I almost gave up at the loop of death."

Further explanation depicted the 'loop of death' as section 2, which, in addition to exploring the extent to which respondents agree that they have been exposed to each of the leader development activities, also, in subsequent questions, needed them to respond to their evaluation of the relevance of the same activities. This could have increased the demand on respondents' cognitive powers and make the questionnaire more challenging to complete. As one respondent described it, "It was a little frustrating as it felt as though I am answering the same questions over and over." This feedback suggested that with little difference in interpretation of closely related activities (For instance, 'On-the-job learning' vs 'Stretching work/additional responsibility' or 'Mentoring' vs 'Leader-to-leader development' vs 'Peer to Peer mentoring'), in addition to the burden of recall, the specificity of some of the 35 activities was not strong enough (Ayhan and Işiksal, 2004; Kjellsson, Clarke and Gerdtham, 2014). This necessitated dropping activities that, though different scholars had uniquely identified as relevant (See Chapter 2), some could be combined or one taken to represent others.

Initially, nearly all available leader development approaches as identified in the literature were included for assessment in section 2. With the pilot testing, it was evident that some approaches are considered less relevant in the development of leaders within the study context and are not widespread in use. Moreover, the literature suggests that a much more concise list exists that needs further examination in the context of this study to answer the study research questions. Section 2 was consequently truncated by reducing the approaches under study from 35 to 10. A balance was made between collecting desirable data from fewer respondents and collecting essential data from a larger sample size by making it easier to complete the questionnaire. The rationale to include some leader development approaches and eliminate others was based on the literature as described below.

3.9.3.2 Popular and relevant approaches

Raelin (2011) argues that work-based learning and mentoring addresses the inadequacies of the classroom approach and is effective in leadership development. It is an idea gaining popularity (Hoffman, Yeh and Casnocha, 2019; Moldoveanu and Narayandas, 2019). Furthermore, in a 2016 survey of HR professionals, the Society of Human Resources Management, with members in more than 165 countries including African countries, found that the top five leader development methods that were expected to become essential in the future included, “Coaching, Leader-to-leader development, On-the-job/in-role learning, Mentoring, Social media,” (SHRM, NOCA, and EFMD, 2016, p. 28). In contrast, events, lectures, video and podcasts, were projected to become less important activities in developing leaders. The same study found that the top 10 most popular leader development activities offered by organisations to grow their leaders included:

> On-the-job learning…classroom/in-person courses…coaching, online courses (e.g., e-learning, webcasts, university programs), mentoring, cross-functional training…leadership forums (i.e., opportunities to meet with senior executives during organised events or other semiformal settings)…high-visibility assignments/opportunities to work with executives (e.g., executive task force)…matching employees with “stretch” opportunities...job rotation (SHRM, NOCA, and EFMD, 2016, p. 29).

Whereas Lee and Hur’s (2015) study of the effects of participating in mentoring was limited to self-leadership and the context of students, it also underscores the importance of mentoring. While calling for more research in this area, Gumus and Bellibas (2016) observe that traditional professional development approaches such as “courses, conferences, or observational visits” (Gumus and Bellibas, 2016, pp. 296–297) have no significant effect on leadership unless critical contextual and content applications suit the desired purposes. They found that mentorship, research activities and networking opportunities and hands-on-experience are more likely to lead to effective leadership. Whereas the Gumus and Bellibas (2016) study was in the context of instructional leadership in educational institutions, this potential in contemporary professional development activities has been identified elsewhere (Orvis and Ratwani, 2010; Mazzoccoli and Wolf, 2016).

3.9.3.3 Efficacy in engendering leadership effectiveness

Notwithstanding that a leader development activity may be universal and relevant; a question arises as to the extent exposure to such activity might lead to learning leadership or engendering leadership effectiveness. Whilst this is a question that the current study sought to establish, particularly in the context of natural scientists in Uganda, the literature is full of theoretical frameworks that suggest some activities are more efficacious than others (McCormick, 2001; Collins and Holton, 2004; SHRM, NOCA, and EFMD, 2016; Lacerenza *et al.*, 2017; Liu *et al.*, 2020). Kolb (1984) outlined his theory of experiential learning and argued that processes that provide a concrete experience upon which one can reflect and synthesise concepts would lead to learning. Despite criticisms (Kayes, 2002), many scholars support the stance that experiential learning methods are more strongly linked to effective learning given their practical hands-on nature (Kolb and Kolb, 2009b; Kolb, 2014; Perry *et al.*, 2017). This suggests that activities rich with experiential processes such as on the job learning or stretch opportunities to act in a challenging leadership role with substantial delegated authority have "extraordinary impact" (Heath and Heath, 2017, p. 121).

Lord and Hall (2005) suggest that effective leadership requires higher-order thinking skills, the kind of skills that Bloom defined as analysing, evaluation and creating (Bloom *et al.*, 1956; Nentl and Zietlow, 2008). The development of these skills in leadership, may not be sufficiently nurtured through experiential processes alone and may require a combination of experience and activities more aligned to the cognitive stage development theory such as coaching, training and mentoring (Turesky and Mundhenk, 2007; Lacerenza *et al.*, 2017). Literature also suggests that activities related to self-development, and developmental learning experiences outside of work or academic study—from childhood to retirement—are essential in leader development and more research has been called for, to better understand the nature of leader development before adulthood, making a case for "developmental experience windows" such as peer-interactions, presence of role models, leading in sports or attending leadership forums (Liu *et al.*, 2020, p. 4). For this reason, participating in leadership activities during undergraduate study or technical training was included as a vital leader development activity relevant for natural scientists (Ewing, 2009; Ronald *et al.*, 2011; Lee and Hur, 2015; Perry *et al.*, 2017).

3.9.3.4 Relevance in the post-COVID-19 world

With COVID-19 billed to have changed the world and created a 'new normal', it was imperative that the study examines leader development in the context of the emerging realities (NEJM Catalyst, 2020; Lobdell *et al.*, 2020; Ratanjee and Foy, 2020; Stoller, 2020). There was a notable uptake of online and self-directed learning approaches to education and learning as a result of COVID-19 (Bao, 2020; Chiodini, 2020; Li and Lalani, 2020; Murphy, 2020). This suggested that more people have experienced or were more open to this kind of learning opportunities and that a return to the 'old normal' is unlikely (Nistor *et al.*, 2019; Ryan, Henderson and Phillips, 2019; Agarwal and Kaushik, 2020; Chiodini, 2020; Daniel, 2020; Girik Allo, 2020; Li and Lalani, 2020). The interviews and survey therefore, included these approaches in order to understand participant experiences and relevance to natural sciences, adequately. Furthermore, COVID-19 underscored the need for soft skills such as crisis communication, diplomacy and proactive problem-solving. Other leadership skills, such as emotional intelligence, self-awareness, and empathetic leadership, were also identified as critical among natural science leaders (Dirani *et al.*, 2020; Ratanjee and Foy, 2020; Stoller, 2020; Wu, Connors and Everly, 2020). Activities associated with nurturing these leadership skills such as mentoring, coaching and 360-degree feedback were also included in the survey (Rosti and Shipper, 1998; Conger and Toegel, 2002).

Therefore, the leader development activities/approaches retained for this study were those that the literature identified as more impactful and linked to the development of higher-order thinking skills as depicted in chapter 2, Table 2.3 (page 63) . Others were included based on the emerging consensus from the qualitative interviews. Emerging methods such as e-learning in all its forms (self-directed, virtual instructor-led, interactive and adaptive learning) were particularly included because of the likely surge in popularity as a result of the extensive adoption of online learning following the COVID-19 pandemic.

3.10 Ethical considerations

Underlining the importance of ethics, Wassenaar and Slack (2016) argue that poor ethics will diminish the validity and usefulness of research in much the same way as poor methodology. They call for thorough engagement with Research Ethics Committees (RECs) and to follow crucial frameworks such as South Africa's Regulation 719 on health research, which "defined broadly…includes any research which contributes to knowledge of social or psychological processes in humans" (Wassenaar and Slack, 2016, p. 308). This study followed UKZN's 'Research policy V' and attendant guidelines (UKZN, 2014). As such, it was scrutinised and authorised by UKZN's Human Social Sciences Research Ethics Committee (HSSREC). Additionally, Uganda Christian University's REC (UCUREC) evaluated and approved the study in accordance with Uganda's legal framework (UNCST, 2016). Wassenaar and Slack recommend that beyond stating REC approvals, studies ought to report on ethical considerations themselves. These are outlined below.

3.10.1 Informed consent

An information sheet was provided to each participant before they could decide to participate or not (See Appendix 2 and 3). It included the purpose of the study, participant rights and how they might access a report submitted to their organisation. Informed consent was then expressly sought alongside permission to record interviews. The study did not involve active or passive deception (Athanassoulis and Wilson, 2009; Monica, 2016). Nonetheless, to ensure that deception was minimised, all interviews were conducted by the principal investigator and full information about the study given as outlined in the information and informed consent sheet. Additionally, the following were ensured:

1. The audio taping of interviews used non-discreet equipment, and only after informed consent was explicitly obtained. Full disclosure was provided on how the recorded material would be transcribed and who would have access to the audio recording before its destruction and how it would be destroyed
2. An opportunity was provided to respondents to ask questions before starting interviews and at any point during the interviews
3. No details about the study purpose, methods, participant selection were omitted
4. The interviewer ensured that respondents took time to read through the information sheet

3.10.2 Participant protection

The information sheet highlighted that the research was for a doctoral thesis and that any publications would not refer to individual-identifying information but aggregated data. Access to signed consent forms and recorded interviews would be by the principal researcher, transcriber and the supervisor only. Data analysis and reporting did not include metadata that can identify a particular respondent. Respondents were given unique identifiers instead of names, and any quotations used in the study did not bear traceable participant details. Where respondents mentioned names of people in the case organisation, the transcripts were redacted, and quotations carried pseudonyms where necessary. Additionally, given that qualitative interviews have a penchant for revealing sensitive data, the risk of such information being linked back to the participant was minimised by:

1. Starting the audio recording after the participant had introduced themselves
2. Not writing any personal information or names in the interviewer's notes and
3. Training the transcribing assistant in ethics and how to maintain confidentiality.

Sensitive personal information about the participant, that was not relevant to the study objectives was redacted from the transcripts. Transcripts were stored on a secure encrypted cloud server, with a two-factor password protection system.

3.10.3 Incentives

The study had no monetary or other incentives for participation in the interviews. However, the social value of the research and the higher ideals of contributing to a greater understanding of leader development was emphasised on the information sheet. Further, in order to encourage participation in the survey, a downloadable leadership e-book was offered as an incentive on completion.

3.10.4 Minimising risk

During fieldwork, ethical practices outlined in the approved protocol were followed. Research participants were informed of all risks associated with the study and protections, in the process of administering consent. Contact information of the study supervisor and the contact persons from both UCU REC and HSSREC were provided.

To ensure confidentiality, all interviews were conducted within the confines of the selected persons' offices and at the most convenient times. Online, face-to-face interviews were adopted in line with national and HSSREC guidelines for research during COVID19 in order to minimise risks to the researcher and the participants. Participants were advised to social distance, and to secure a private place for the online interview. Besides minimising distractions, this maintained the health and safety of respondents and allowed discussing issues considered sensitive or which participants did not wish their work colleagues to know. Similar procedures for consent, safety and privacy were followed for FGDs.

The research activities were non-invasive, and potential risks to participants were minimal. Potential risks to participants included breach of confidentiality and psychological discomfort, stress and inconvenience. For instance, feelings of discomfort by the respondent's recounting of their promotion history were considered a risk. Participants were advised to say only that which they felt comfortable saying. They could withdraw their comments or refuse to be quoted. In the surveys, they could refuse to answer a question by skipping it, and that was coded as missing data.

3.10.5 Social and cultural sensitivity

The researcher was familiar with Ugandan culture in general and as a natural scientist with experience in fields such as engineering, public health and agriculture, appreciated the decorum and perspectives of technical personnel. Additionally, given that the case study organisations were government agencies with unique organisational cultures, a formal, diplomatic and respectful approach was taken in dealing with the participants. Gatekeeper authorisation was obtained with full knowledge of the heads of each organisation—Permanent Secretary and Commissioner General respectively—who then delegated authority to the relevant HR personnel to support the researcher. All meetings at the premises were preceded by a courtesy call with this HR personnel, who advised as to the most convenient times and periods to conduct interviews in order not to disrupt ongoing work.

Interviews were scheduled ahead of time using *Calendly* software with automatic reminders provided to the participant. HR personnel supported the process by enlisting email addresses and phone contacts of eligible leaders as per the inclusion criteria and left it to the researcher to send emails with the information sheet to enlist participation. In cases of senior-level respondents, contingencies for interruption of the interviews (in case the respondent had to attend to urgent matters) were built into the interview schedule allowing for intermitting or rescheduling. Where necessary, interviews were postponed at the request of the respondent as flexibility in scheduling had been expected among government personnel at senior-most levels. Guidance on any organisation specific cultural sensitivities was sought from the HR managers from time to time. Feedback to the researcher from respondents was obtained through the HR managers after the first few interviews, mostly relating to scheduling and interview length, and corrective actions were taken.

3.11 COVID-19 effects on the study context

The study was conducted during the COVID-19 pandemic period with the pilot testing of instruments conducted in March 2020 and some phase 1 interviews conducted in May 2020. The government restrictions on face-to-face meetings and travel meant that interviewing could not continue face-to-face. Moreover, the case study organisations were not operating normally, with most staff working from home, thereby limiting access to participants. A revision was made in the study protocol, and approval sought to use online interviews using a variety of available technology that the respondents could easily access or were comfortable with. Most interviews were conducted using Zoom, Skype, and MS Teams. A few were conducted by telephone in cases where internet connectivity was difficult or where the respondent preferred such technology. Respondent's preferences were respected. As required by the REC, revisions were made to the informed consent form and participants were requested to concede or not to being audio/video recorded considering that signatures would be challenging to obtain. The revised protocol was approved by the HSSREC.

An emerging concern for the study was that COVID-19 escalated the need to understand leadership and leader development amongst specific sub-disciplines of natural sciences—medicine and public health (Binagwaho, 2020; NEJM Catalyst, 2020; Häyry, 2021). The world was thrown into an environment where the influence of health professionals was heightened; and organisations, teams and nations looked to these scientists to provide leadership. Some of these natural scientists who had hitherto been in oblivion tacked away on their small teams were now under the spotlight to provide leadership in a volatile and uncertain crisis environment (Nembhard, Burns and Shortell, 2020; Stoller, 2020). Those that had ignored leader development were being exposed by the crisis. This has heightened the conversation around the need to invest more in developing leaders, particularly among health professionals, with calls for research in this area (Moldoveanu and Narayandas, 2019; Lobdell *et al.*, 2020; Stoller, 2020; Yenice, 2020). Research exists to contribute to solving the problems of the day (Auken *et al.*, 1993). This study, therefore, had the opportunity to lean in and actively contribute to the understanding of how leader development works in these contexts.

Consequently, having realised that the participants enlisted for interview within the case study organisations included no medical/health professional and that the quantitative phase of the study was unlikely to have enough of this cadre of natural scientists to respond, this group was purposively sampled. Ten leaders in the medical profession were interviewed for phase 1 of the study. The cross-sectional survey was also extended beyond the two case study organisations to registered health practitioners through the Uganda Medical Association. The survey link was shared through the Secretary-General of the association and the Chairperson of Publicity and Mobilization.

3.12 Data management and analysis

3.12.1 Qualitative data analysis

As a hallmark of rigorous qualitative studies, data analysis commenced with the earliest interviews so as to discuss new themes and patterns of data that emerge with subsequent participants (Antonakis *et al.*, 2004). The interviews and FGDs were backed up with cloud storage to avoid data loss and later retrieved and analysed using thematic analysis and framework analysis methods (Insch, Moore and Murphy, 1997). NVivo 12 software was used to code and organise data in line with themes from the research objectives and research questions and not merely generate quantitative analyses that software packages can provide when used alone. The mapping of the research objectives, research questions, and tools shown in Table 1.1 (chapter one, section 1.6, page 10) guided the thematic analysis and the emerging themes used in coding.

Interview notes were coded immediately after the interview and included in the NVivo 12 codebook. Themes from these notes were used in subsequent interviews for further exploration through probing and bouncing off the emerging categories and ideas. The interviewer then transcribed interviews to get further immersed in the available data before subsequent interviews. As such, coding and data collection were undertaken simultaneously. The transcribed interviews were analysed using thematic analysis methods (Insch, Moore and Murphy, 1997; Corbin and Strauss, 2008) in accordance with the conceptual framework and themes emerging from the data. NVivo 12 software was used to code and organise data and to conduct cross-case analyses across organisational context, levels of seniority, and gender. Participants were given sequential numbers alongside three letters—the first denoting their comparator group (S-Scientist, N-Non-Scientist), the second denoting their professional field or discipline (M-Medicine, E-Engineering, A-Agriculture, T-Tax administration), and the third denoting gender (M-Male, F-Female). For example, 9SMM denotes the ninth respondent who is male and part of the scientist group practising medicine. Additional characteristics such as level of seniority were added when reporting and quoting respondents in order to give context to the kind of participant(s) that voiced a particular viewpoint. For quotations from FGD participants, the profession and gender were highlighted, for instance FGD-Scientist-Male represents a male participant in the scientist FGD.

In line with the constructionist approach and the preeminent value of qualitative research, Creswell (2013) and Yin (2018) have advised that researchers must stay close to the data and maintain the chain of evidence in the voices of the respondents during qualitative data analysis. As such audio recording of the interviews and FGDs were played repeatedly during analysis as a way of exploring themes. Using a technique Yin (2018) describes as pattern matching and explanation building, interesting ideas were coded as themes or sub-themes using nodes in NVivo 12 to group similar ideas that answer the 'how' and 'why' aspects of the research questions. These codes initially emerged from themes as guided by the research objectives, literature review and the attendant conceptual framework, but more were identified from the data as each interview transcript, and voice recording was explored. Considering that the researcher has a background in natural sciences, to maintain reflexivity during the analysis, an "interpretative frame of reference" suggested by Charmaz (2005, p. 509) was used. Reflexivity improves the credibility of the research as it addresses impartiality and potential bias in the way a researcher interprets qualitative research (Dodgson, 2019). During analysis, in this study, notes and assumptions were written and held up against the descriptions of themes and codes as outlined in the codebook (see Appendix 6). The codebook was consulted throughout the coding to ensure consistency and that only themes backed up by the data were coded. Once each transcript was coded, queries and text searches across interview transcripts were performed to establish if and how different respondents discussed particular themes, leading to additional coding as necessary. Using NVivo 12 visualisation and collating tools, all text relating to a particular theme was gathered in one place to visualise and reflect upon how the data 'spoke' about a given theme.

Additionally, exploration of how the different case classifications (scientist vs non-scientists and levels of leadership seniority) spoke about a theme was conducted. This cross-case analysis and iterative reflections on the literature resulted in an inductive process where relevant first-order nodes were grouped into higher-order themes or linked to related themes (Corbin and Strauss, 2008), occasioning the development of a model. The emerging insights from the data were noted and written out in a memo and later reported on in chapter four as the findings.

Considering that the study employed a mixed-methods approach, the weaving approach to reporting findings was adopted. Fetters *et al.* (2013) have advised that to make the most of mixed-methods designs, integration is important, as it can allow for confirmation when the findings from qualitative data align with those from the quantitative data and for expansion of understanding when they diverge. They define the weaving approach as one that "involves writing both qualitative and quantitative findings together on a theme-by-theme or concept-by-concept basis" (Fetters, Curry and Creswell, 2013, p. 2142). While the qualitative analysis was conducted separately, additional reflection on the qualitative data (especially the focus group discussions) was performed after the quantitative data analysis as a way of identifying insights that could shed more light on the emerging quantitative findings and the overall phenomenon of leader development among natural scientists (Stentz, Plano Clark and Matkin, 2012; Fetters, Curry and Creswell, 2013; Creswell and Plano Clark, 2018).

3.12.2 Quantitative data analysis

Survey data was exported from *SurveyMonkey* to SPSS v27 for analysis using descriptive and inferential statistics. For instance, frequencies, percentages, totals, means, and 95% confidence interval for the mean were generated. Statistical correlation between leader development approaches and leadership effectiveness was evaluated. Comparative analyses to establish differences between natural scientists and non-scientists and examining the relationship between determinants of leader development, exposure to leader development, and dimensions of leadership effectiveness were carried out.

The principal analytical tool included Analysis of Variance (ANOVA) to compare leadership effectiveness and exposure to leader development approaches between scientists and non-scientists. On items where there was a need to identify factors associated with the outcome variables (leadership effectiveness), binary logistic regression modelling was applied. Binary logistic regression is a modelling technique that enables the investigation of relationships between multiple independent variables (e.g., attitude, intention and exposure to different leader development activities) and one dichotomous outcome (i.e., low and high leadership effectiveness). All analyses used a 5% significance level, and p-values were then used to determine the extent to which high exposure to a particular leader development activity predicts high leadership effectiveness and whether such an association is statistically significant.

To establish the variable of leadership effectiveness, a frequency analysis was conducted to get a feel of the data. A composite measure of leadership effectiveness combining the means of each dimension in the leadership effectiveness scale into a composite mean was established. The frequency distribution of this composite leadership effectiveness was plotted. The minimum score was 3.00, while the maximum was 4.97. The relative spread of the means was as shown in Table 3.5 below:

Table 3.5 Frequency distribution for the leadership effectiveness index

Overall Leadership Effectiveness (Mean score)	Frequency	Per cent
1:00 - 2.99	0	0.0
3.00 - 4.00	21	12.6
4:01 - 4.50	71	42.6
4.51 - 5:00	73	44.8

Given the spread of the data in Table 3.3, in accordance with guidance provided by De Vaus (2002), the dependent variable, leadership effectiveness, was established and dichotomised as Low Effectiveness for mean scores 3.00 – 4.40 (representing 49.1%) and High Effectiveness for means scores 4.41 – 5.00 (representing 50.9%). In line with objective three of the study, statistical analyses assessing the relationship between exposure to each of the leader development activities and the composite leadership effectiveness were carried out using UNIANOVA analyses. Similar analyses comparing leadership effectiveness and the determinants of leader development behaviour were carried out. The UNIANOVA technique enables regression analysis and analysis of variance for a dependent variable (in this case, leadership effectiveness) by several factors or variables (in this case, leader development approaches and using demographic characteristics as controls). A univariate approach was considered appropriate because only one dependent variable and multiple independent variables were involved in the current study.

3.12.2.1 Scale development, factor analysis and reliability analysis

Factor analysis is a process used to establish scales that measure a construct appropriately by way of reducing items to those that measure the same concept. Principal Axis Factoring (PAF), which measures the variance shared with other variables, was used to explore which items collectively should be maintained for each dimension of leadership effectiveness and determinant of leader development. To select which items were loading properly for a given dimension of leadership effectiveness or determinant of leader development (and should therefore be maintained), those with an eigenvalue above one were selected in accordance with Kaiser's criterion (Hinkin, 1995; Field, 2018). Furthermore, the scree plot was also considered to select the factors before the scree plot appears to level off in accordance with Cattell's (1966) method.

Additionally, the varimax rotation method was used to examine the factor loading of each item on each factor. Factor loading signifies the strength of the association between individual items and a factor, with a factor loading greater than 0.3 considered as the minimum for signalling greater association (Hair *et al.*, 1998). Items not loading with other factors were removed and factor analysis repeated until a subset of items loading well was maintained as the scale and subsequently taken through reliability tests. During factor analysis, user and system missing values were excluded as these would unreasonably affect the analysis. The emerging scales after factor analysis and their reliability scores for Cronbach's Alpha are presented in section 3.11.2.2 below. With all the 60 items in the leadership effectiveness questionnaire, the instrument's reliability was found to be sound, with a Cronbach's Alpha of 0.952. Cronbach's Alpha is a measure of internal consistency and scale reliability, depicting how closely a set of items measure the same thing. According to Hulin, Netemeyer and Cudeck (2001), conventional standards suggest that a Cronbach's Alpha of 0.6-0.7 suggests an acceptable level of reliability while 0.8 or higher is considered very good. However, values larger than 0.95 are not positively great since they might indicate redundant items (Hulin, Netemeyer and Cudeck, 2001). A large number of items (six per scale dimension) had been maintained after the pilot testing as part of the process to identify the appropriate scale items and produce a tool for measuring leadership effectiveness and determinants of leader development within the context of natural scientists and a developing country setting—a contribution of the study. Consequently, each leadership effectiveness dimension and determinant of leader development was evaluated for internal consistency with some of the items that demonstrate poor loading and inconsistency in measuring that particular dimension deleted following principle axis factor analysis procedures and guidelines (Hinkin, 1995; Field, 2018; Crawford and Kelder, 2019) and looking at the inter-item correlation and covariance so as to delete items whose deletion would increase the Cronbach's Alpha (Field, 2018). The remaining items that make up the final scale and measure of leadership effectiveness are outlined below.

3.12.2.2 Factor analysis and reliability analysis for leadership effectiveness

The 60 items in the questionnaire section measuring leadership effectiveness—the dependent variable were subjected to factor analysis, as shown in Tables 3.6 and 3.7 below.

Table 3.6 Cronbach's Alpha coefficient for the survey instrument

Reliability Statistics	
Cronbach's Alpha	N of Items
0.952	60
0.956	58

Table 3.6 above shows the reliability of the survey questionnaire in measuring leadership effectiveness. At 0.952, the Cronbach's Alpha was excellent for all 60 items. However, as described in 3.12.2.3 below, two items were dropped after factor analysis to enhance instrument validity, at which point the instrument reliability also improved with the Cronbach's Alpha increasing to 0.956.

Table 3.7 Factor analysis for leadership effectiveness

	Factor															
Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
q7_1	0.468			-0.353												
q7_2	0.449		-0.271				0.277									
q7_3	0.606					0.311										
q7_4	0.481															
q7_5	0.587															
q7_6	0.414		-0.341											0.251		
q8_1	0.525	0.363														
q8_2	0.485													0.254		
q8_3	0.397	0.362		0.273												
q8_4	0.306	0.400		0.286												
q8_5	0.532															
q8_6	0.359	0.260	0.291													
q9_1	0.565											-0.315				
q9_2	0.468				-0.267											
q9_3	0.338				0.350				-0.286							
q9_4	0.646									-0.280						
q9_5	0.516											0.258				
q9_6	0.460					0.496										
q10_1	0.634									0.310						
q10_2	0.459															
q10_3r			-0.361					0.341					0.250			
q10_4	0.544															
q10_5																
q10_6	0.408				0.292										0.327	
q11_1	0.607															
q11_2	0.643															
q11_3	0.570												0.283			
q11_4	0.654						-0.328									
q11_5	0.475							0.306								
q11_6	0.519										-0.271					
q12_1	0.711															
q12_2	0.609															
q12_3	0.628					0.261										
q12_4	0.686															
q12_5	0.564															
q12_6	0.502			-0.275												
q13_1	0.535															
q13_2	0.650			-0.306												
q13_3	0.598		0.263													
q13_4	0.524		0.328													
q13_5	0.594		0.275													
q13_6	0.531															
q14_1	0.696															
q14_2	0.661															
q14_3	0.577															
q14_4	0.653															
q14_5	0.701				-0.382											
q14_6	0.689				-0.282						-0.301					
q15_1	0.499							-0.28								
q15_2	0.577								0.327							
q15_3	0.632								0.403							
q15_4	0.585			-0.276		0.265										
q15_5	0.579															
q15_6	0.371															
q16_1	0.492	-0.450														
q16_2	0.585	-0.327														
q16_3	0.442	-0.472	0.268													
q16_4	0.573	-0.436		0.296		-0.337										
q16_5	0.549	-0.287														
q16_6	0.374		0.352							0.275						
Eigenvalue	18.1	2.6	2.2	1.9	1.9	1.6	1.5	1.5	1.4	1.4	1.3	1.2	1.1	1.1	1.1	1.0
% of total variance	29.4	3.6	2.8	2.4	2.4	2.1	1.8	1.7	1.5	1.5	1.4	1.2	1.2	1.1	1.1	0.9

Extraction Method: Principal Axis Factoring. 16 factors extracted

Table 3.7 above shows that nearly all items in the leadership effectiveness questionnaire load significantly on factor 1 and account for 29.4% of the total variance. Given the nature of the items loading on factor 1, this factor is labelled leadership effectiveness. Only two items do not load on the first factor—q10_3r, 'I ignore past decisions when considering current similar situations' and q10_5, 'I consider how I could have handled the situation after it was resolved' which are both under the strategic thinking dimension. This is possibly because respondents did not understand item q10_3r as it was reversed. Furthermore, the language of q10_5 may not have been simple enough to understand as it does not load on any factor. The two items were subsequently dropped, and a reliability analysis revealed that the internal consistency of the items was high, with a Cronbach's Alpha of 0.956 for the 58 items measuring leadership effectiveness (See Table 3.6 above). This implies that the questionnaire, on the whole, was a valid measure of leadership effectiveness, and therefore the composite mean for all reliable 58 items was computed as the dependent valuable—leadership effectiveness.

Furthermore, the rest of the factors individually account for a small percentage of the total variance. For example, factor two accounts for only 3.6% of the total variance, and factors three, four, five and six account for 2.8%, 2.4%, 2.4%, and 2.1%, respectively. Four items load well on factor 2, and looking at the items, this factor was labelled emotional intelligence. Three items loaded well on factor 3 and given the highest factor loadings, which relate to innovation, creativity and problem solving, factor 3 was labelled innovation. One item loads significantly on factor 4 and relates to problem-solving, the factor was, therefore, labelled problem-solving. Two items load significantly on factor 5, and looking at the items, the factor is labelled servant leadership. Two items load significantly on factor 6 and relate to feedback. The factor is therefore labelled performance feedback. Although factors 7 to 16 have an eigenvalue above one, they are disregarded given that they each account less than 2% of the total variance.

3.12.2.3 Factor analysis and reliability analysis for dimensions leadership effectiveness

While the data shows that the emerging dimensions of leadership effectiveness aligned to the six factors where items significantly load—emotional intelligence, innovation and creativity, problem-solving, servant leadership and performance feedback, 58 items significantly load on the factor labelled leadership effectiveness, consequently aligning with the literature on the ten dimensions that were included in the questionnaire. Factor analysis and reliability analysis was therefore conducted for each of these dimensions following similar steps in 3.12.2.2 and as described in 3.12.2.1.

(a) Role ownership

Only one factor was extracted, indicating that all items were loading well on the same factor, which explained 42% of the variance. Given that all items were loading on the same factor, none was deleted.

Moreover, for the six items, the Cronbach's Alpha was 0.701 and 0.713 when based on standardised items, which is in the acceptable range. It would increase to 0.72 if the item 'I take personal responsibility for team failures' was deleted. However, the increase would be marginal and considering that it is an item among those that had a lower mean, it was maintained in the scale to counter-balance and minimise extreme response style errors, which are typical to Likert scale surveys (Batchelor and Miao, 2016; Liu *et al.*, 2017).

(b) Emotional intelligence

Two factors were extracted, with the first factor accounting for 33.2% of the total variance while the second factor accounted for 7.7% of the total variance. All six items were loading significantly on factor 1, while only one item loaded significantly on factor 2. For the six items, the Cronbach's Alpha was 0.724 and 0.730 when based on standardised items, which is in the acceptable range. No item was deleted as this would lower the Cronbach's Alpha.

(c) Servant leadership

All six items were loading significantly on factor 1, which was the only factor extracted. For the six items, the Cronbach's Alpha was 0.698 and 0.70 when based on standardised items, which is in the acceptable range. Deleting any item would lower the Cronbach's Alpha. They were, therefore, all maintained.

(d) Strategic thinking

Factor analysis revealed two factors extracted where only four items were loading significantly on factor 1 while one item was loading significantly on factor 2. One item was loading in a different direction on factor 2. Items not loading on factor 1 were deleted and reliability analysis conducted on the remaining four items. The items deleted included q10_3r—'I ignore past decisions when considering current similar situations' and q10_5—'I consider how I could have handled the situation after it was resolved', which were the same items not loading on leadership effectiveness as seen earlier in 3.11.2.2. Moreover, other items negatively correlated with the reversed item 'I ignore past decisions when considering current similar situations' even though it was reversed—depicting that perhaps respondents did not understand that item or that both poorly loading items were poorly worded. Moreover, as Mumford *et al.* (2007) have argued, the development of leadership skills is cumulative. Strategic thinking skills are developed at a later stage as the leader's responsibility and complexity of the problems they face increases (Mumford *et al*., 2007, Conger 1993). Therefore, these poorly loading items may have been asymmetrical to the majority of the respondents' level of exposure and experience. Subsequent reliability analysis on the remaining four items showed a Cronbach's Alpha of 0.64, which is acceptable reliability.

(e) Ethics and accountability

The factor matrix revealed that only one factor was extracted with all six items loading significantly on factor 1, which accounted for 38.6% of the total variance. Subsequent reliability analysis for six items showed a Cronbach's Alpha of 0.77, which is in the acceptable range. Therefore, no item was deleted.

(f) Performance management

All six items were loading significantly on factor 1, which was the only factor extracted in the factor matrix and accounted for 42.5% of the total variance. For the six items, the Cronbach's Alpha was 0.80, which is considered excellent. As such, no item was deleted.

(g) Decision making and problem-solving

All six items were loading significantly on factor 1, which was the only factor extracted in the factor matrix and accounted for 42.2% of the total variance. For the six items, the Cronbach's Alpha was 0.81, which is considered excellent. No item was deleted.

(h) Team leadership

All six items were loading significantly on factor 1, which was the only factor extracted in the factor matrix and accounted for 51.9% of the total variance. For the six items, the Cronbach's Alpha was 0.86, which is considered excellent. No item was deleted.

(i) Communication skills

All six items were loading significantly on factor 1, which was the only factor extracted in the factor matrix and accounted for 30.9% of the total variance. For the six items, the Cronbach's Alpha was 0.71, which is considered acceptable. No item was deleted as this would not have a significant improvement on the Cronbach's Alpha. Whereas deleting the item 'I argue persuasively for my point of view' would have increased the Cronbach's Alpha, albeit marginally, it was considered relevant given the face validity in its ability to measure communications skills.

(j) Innovation and creativity

All six items were loading significantly on factor 1, which was the only factor extracted in the factor matrix and accounted for 40.8% of the total variance. For the six items, the Cronbach's Alpha was 0.74. The item 'I don't take credit for other people's ideas' was deleted because it was amongst the lowest loading on factor 1 and would not only increase the Cronbach's Alpha to 0.805 but also increase total item correlation and reduce the scale variance, thereby increasing reliability and internal consistency while also reducing the respondent's burden to answer many questions in future surveys using this tool.

Table 3.8 Reliability analysis for dimensions of leadership effectiveness

Dimension	**Cronbach's Alpha for the scale**
Role ownership	0.70
Emotional intelligence	0.72
Servant leadership	0.70
Strategic thinking	0.64
Ethics and accountability	0.77
Performance management	0.80
Decision making and problem-solving	0.81
Team leadership	0.86
Communication skills	0.71
Innovation and creativity	0.81

Table 3.8 above summarizes the reliability analysis for all dimensions of leadership effectiveness.

3.12.2.4 Factor analysis and reliability analysis for determinants of leader development

Following a similar process, the scale items measuring the five determinants of leader development were analysed for unidimensionality, validity and reliability. Where items did not load significantly on factors responsible for the largest variance, and by whose deletion the Cronbach's Alpha would increase to an acceptable range, these were deleted.

Table 3.9 Reliability analysis for determinants of leadership effectiveness

Dimension	**Cronbach's Alpha**	**Items deleted/Comments**
Attitude	0.6	Three items were deleted. The scale on attitude had two items. While some scholars suggest that scales should have at least three items (Peter, 1979; Robinson, 2018), other scholars have found that well loading single-item scales or scales with two items are as valid and reliable as the multi-item scales and can be useful in social science research (Zimmerman *et al.*, 2006; Bergkvist and Rossiter, 2007; Nagy, 2010) while also minimising problems with long questionnaires (Steyn, 2017).
Outcome expectations	0.8	No items deleted
Subjective Norms	0.7	No items deleted
Perceived behaviour control	0.6	Two items were deleted as they were not loading significantly on the factor. These were the reversed items—'For me to regularly participate in leader development activities is impossible and 'The decision to develop my leadership capability is beyond my control.'
Intentions	0.7	The item 'I would like to have had more management/ leadership training during undergraduate training' was deleted to increase scale validity and reliability as it was not loading significantly on the factor.

Following the assessment of reliability and the determination of items that would make the scale for the dimensions of leadership effectiveness, and for the determinants of leader development, new variables were created in SPSS using the 'Compute' function, with respective items combined to make the composite variables that represent different dimensions. These composite variables were then used in various descriptive and inferential statistical analyses, and the results are presented in chapter four.

3.13 Trustworthiness, reliability and validity

The preceding sections outlined the steps taken in ensuring the trustworthiness of the data from the qualitative interviews, including selecting respondents from the same organisation (for each of the comparator groups) such that they could reference the same set of facts about leader development opportunities and share their own experiences thereby enhancing the ‘credibility’ and ‘confirmability’ (Shenton, 2004; Babbie and Mouton, 2010; Lietz and Zayas, 2010). Additionally, multiple levels of seniority were interviewed. Moreover, in adopting a constructionist paradigm, the interpretation of the findings and coding of the data used themes that emerged directly from the data and the techniques and procedures taken to analyse the data have been well articulated above (Guba, 1990; Guba and Lincoln, 1994; Lietz and Zayas, 2010). Furthermore, this detailed account of the research process increases ‘dependability’ since other researchers could adopt similar processes and get similar results. The themes arising from the data were presented by staying as close to the data as possible (Creswell, 2012; Creswell and Plano Clark, 2018), identifying the emerging themes alongside the themes determined by the research objectives. Where appropriate, voices from the respondents were included to highlight the themes (Creswell, 2012). Transferability, the degree to which the findings can be extrapolated to another context, was enhanced by studying a wide range of scientist disciplines, management responsibility levels and by describing the context of the study so that readers can make a meaningful judgment about what can or cannot be generalised to other organisations, disciplines and contexts (Babbie and Mouton, 2010; Lietz and Zayas, 2010).

Validity is essential in ensuring that the results obtained from an instrument are accurate in measuring what it purports to measure and that, therefore, the interpretations and conclusions from the study are justified (Sekaran and Bougie, 2016; Creswell and Plano Clark, 2018). For the quantitative data, reliability and validity were enhanced through pilot testing of a questionnaire developed after an extensive literature review, thereby particularly increasing construct validity (Sekaran and Bougie, 2016). Validity was also enhanced by using a panel of experts (Creswell and Plano Clark, 2018). Furthermore, the validity of the questionnaire was tested using factor analysis, while the reliability was enhanced by conducting a reliability analysis as described in section 3.12.2. Only the items identified as loading significantly and enhance scale reliability through internal consistency were included in descriptive and inferential statistics that use scales.

However, the study had some methodological limitations that should be considered. The measurement of leadership effectiveness was limited to perceived leadership effectiveness. Future studies should gain a more objective measure of leadership effectiveness. Additionally, the extensive scope of the study and the limited technical expertise of the principal investigator in scale development meant that there are limitations to the quality of the survey instrument. Nonetheless, the limitation was minimised by following the Crawford and Kelder (2019) process for scale development.

3.14 Descriptive and inferential statistics

A detailed account of the steps undertaken in the cleaning, analysis and interpretation of the data was provided earlier. In chapter four, descriptive and inferential statistics analysed from the quantitative data were presented and juxtaposed with the results of the qualitative data analysis for integration purposes in accordance with a mixed-methods approach. (Fetters, Curry and Creswell, 2013; Creswell and Plano Clark, 2018). According to Field (2018), Likert-type items and Likert scales can be *ordinal categorical* or *continuous interval,* and researchers may choose to treat them as either. For example, Edmondson (2005) and Jamieson (2004) have argued that Likert scales are ordinal in nature because of the labels that respondents use at the time of answering the questionnaire and that, therefore analysis cannot translate categorical data into continuous data without losing nuances of what respondents actually said (Sullivan and Artino, 2013; Wu and Leung, 2017). However, other scholars have confuted that position, arguing that given the rules that govern Likert-type and Likert statements (for instance, horizontal responses assigned to consecutive integers with response labels anchored at evenly spaced intervals and the verbal labels being polar opposites symmetrically centred around a neutral response), the data can be observed as continuous interval because of its inherent properties (Carifio and Perla, 2008; de Winter and Dodou, 2010; Norman, 2010).

While there remains a debate as to which is the best way to treat Likert type data, some scholars have advanced that the choice does not matter much in practice as long as the statistical tests that follow align with the choice of treating the data as ordinal categorical or continuous interval (Zand and Borsboom, 2009; de Winter and Dodou, 2010). Field (2018) and Jamieson (2004) have advised that for individual Likert-type statements (items that satisfy the Likert rules but stand alone as statements), ordinal categorical is a better classification and that, therefore, the statistical tests used should be nonparametric and not report means and standard deviations. On the other hand, scholars advise, Likert scales (which combine several items measuring the same construct) should be treated as continuous interval data and that therefore means, standard deviations and other tests that work with parametric data can be applied to Likert scales (Carifio and Perla, 2008; de Winter and Dodou, 2010; Norman, 2010; Pornel and Saldaña, 2013). As Carifio and Perla (2008) advise, the results presented in chapter four use the nonparametric tests for individual items and therefore report on proportions while the computed variables (such as attitude, beliefs and intentions) that make up the Likert scales are used for calculating and comparing means. The nonparametric tests used included the Chi-square test, while parametric tests included the F-test, Z-test, One-Way ANOVA and UNIANOVA tests (Campbell and Swinscow, 2009; Joshi *et al.*, 2015). Binary logistic regression modelling was also applied to predict the relationship between leader development approaches and leadership effectiveness, with leadership effectiveness categorised in binary terms—low vs high effectiveness.

CHAPTER FOUR — RESULTS

4.1 Introduction

This chapter presents the study findings in line with the research objectives and questions as outlined in the mapping in Table 1.1 in chapter 1 (page 10). The chapter begins by presenting the participants' demographics from both the qualitative and quantitative phases of the study. Given that the study was comparative, data analysis aimed to identify patterns and relationships between the two comparator groups — scientists and non-scientists. Results are presented using tables and graphs accordingly. After presenting the results in an integrated mixed-methods fashion, the findings are summarised, providing a segue into chapter five, where the meaning and implications of the findings are discussed.

4.2 Demographics

As highlighted in chapter three, respondents were drawn from two case study organisations, one representing mostly scientists while the other represented non-scientist leaders. Additionally, medical doctors were purposively selected through their medical association in order to include the sub-discipline of medicine. Figure 4.1 below shows the number and category of leaders interviewed for the qualitative study.

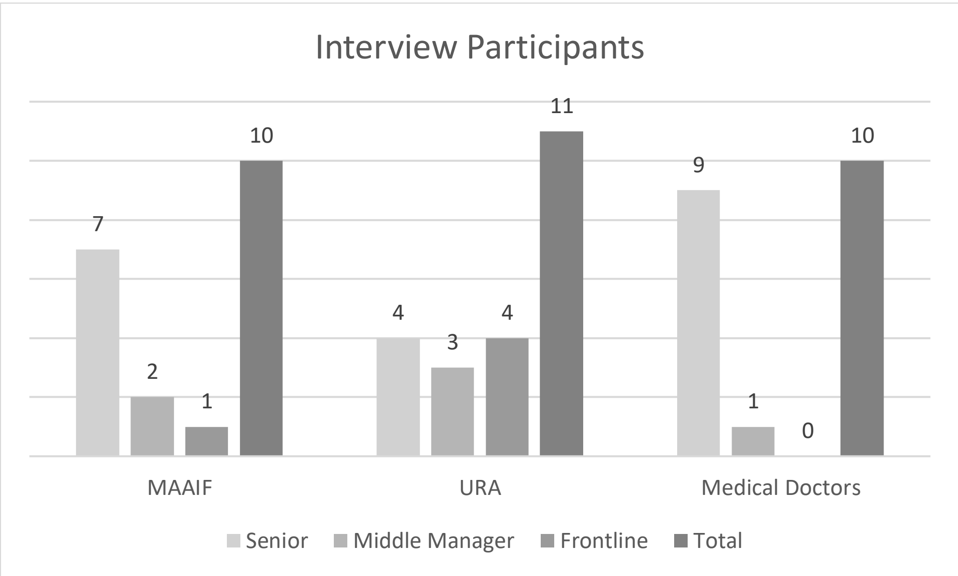

Figure 4.1 Interview participants

Whereas 25 scientists (including those from the medical discipline) and 15 non-scientists were targeted, only 20 scientists and 11 non-scientist accepted and made time to be interviewed. For the scientists, the majority were senior leaders, while for the non-scientists, the majority of respondents were middle management leaders. Among the scientists, the majority were senior leaders. The participants represented a wide range of scientific disciplines, including medicine, engineering and agriculture.

Table 4.1 Response rate

	Leaders Invited	Respondents	Response rate
URA	371	103	27.8%
MAAIF	150	117	78.0%
Doctors	N/A	1	N/A
Overall	521	221	42.4%

Whilst the survey questionnaire was sent to all 521 leaders in the participating organisations, only 221 participants responded, representing 42.4%. Among the 150 individuals holding supervisory positions at MAAIF, only 117 responded—representing 78%. MAAIF leaders included those who identified as 'Other' but specified their affiliate organisation as agencies and partners of MAAIF. Only one medical doctor from the Uganda Medical Association (the gatekeeper) responded to the survey, as the survey was not sent out to other doctors. Among the 371 individuals holding supervisory positions at URA, only 103 responded—representing 27.8%. Among the 221 respondents that took the survey, 80% completed the survey, with 20% skipping some of the questions.

Table 4.2 below shows the characteristics of the survey respondents.

Table 4.2 Demography and socio characteristics of survey respondents

	*Professional Group**		*Total (N=221) %*
	Scientist (n=106) %	Non-scientist (n=115) %	
Sex			
Male	72.6	43.5	57.5
Female	27.4	56.5	42.5
Age group			
20 - 29	2.8	1.7	2.3
30 - 39	28.3	29.6	29.0
40 - 49	24.5	49.6	37.6
50 years and above	44.3	19.1	31.2
Highest level of education			
A level	2.8	0.0	1.4
University/Tertiary	21.7	35.7	29.0
Masters	60.4	64.3	62.4
PhD/Post-Doctoral	15.1	0.0	7.2
Level of management responsibility			
Not a supervisor	3.8	1.7	2.7
Frontline Supervisor	10.4	48.7	30.3
Middle Manager	34.9	27.8	31.2
Senior Manager/Commissioner	24.5	18.3	21.3
Executive/Director Level	26.4	3.5	14.5
Organisational Affiliation			
MAAIF (Including partner agencies)	89.6	19.1	52.9
URA	9.4	80.9	46.6
UMA	0.9	0.0	0.5

**Some proportions do not add up to 100% due to rounding*

Table 4.2 shows that MAAIF had a higher proportion of scientists than URA. Most respondents were male, above 40 years, had Masters as the highest qualification and were mostly in middle management. Some respondents (19.1%) self-classified as non-scientists even though they worked for MAAIF (a largely science-based organisation). Similarly, some respondents (9.4%) self-classified as scientists working for URA. As expected, most leaders at URA are non-scientists, while those at MAAIF are mostly scientists. Leaders who selected 'Other specify' were coded appropriately, with those specifying natural science disciplines such as engineering, chemistry, data science, physics coded as scientists while those specifying arts, humanities, economics and business disciplines such as accounting, tax administration and economics coded as non-scientists. This definition and classification is similar to what some scholars have used in an attempt to delineate between the natural science and humanities or social sciences despite the use of scientific methods in both groups (Ledoux, 2002; Ingthorsson, 2013; Jaffe, 2014). As seen in figure 4.2 below, among the scientists, the discipline represented included agriculture (51.9%), engineering (15.1%), crop science (5.7%), animal science (4.7%), aquaculture (4.7%), forestry (1.9%), medicine (1.9%) and other scientific disciplines (14.2%).

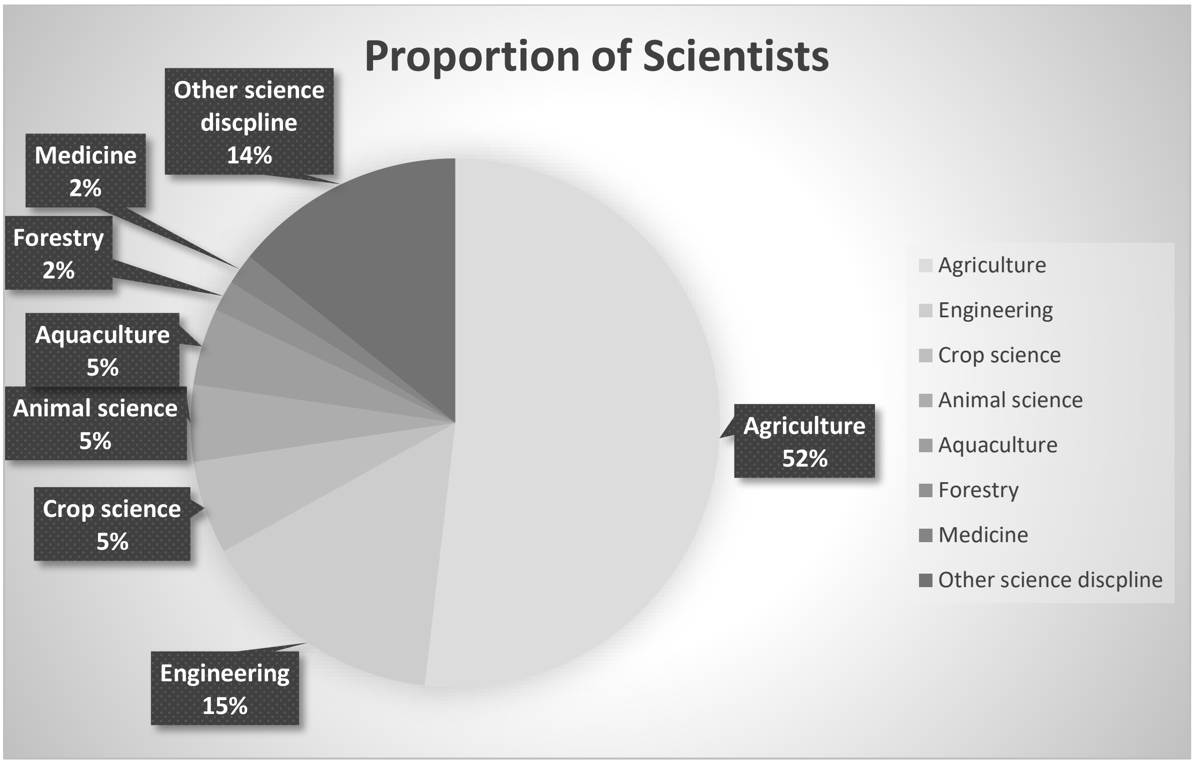

Figure 4.2 Classification of respondents by science discipline

The results appear to show that scientists had a larger proportion of older leaders with 44.3% of scientists 50 years and older compared to 19.1% of non-scientists in the same category. According to some participants in the qualitative interviews, older generation leaders among scientists in Ugandan culture context tend to favour hierarchical, authoritarian approaches compared to young leaders who are open to collaborative leadership styles.

> I wouldn't really want to sound very biased, but my level of interaction and also what I have heard from colleagues and friends sometimes when we are sharing a beer, or watching a football match, there seems to be this bias against people in high positions who are older. Most of them spent a great deal of their early career in rural areas and tend to be not exposed…and tend to be very domineering, protecting their space. This you don't see among the younger ones. The younger people in leadership positions tend to be a lot freer. Maybe it's an age bracket thing. With colleagues in the mid 30s to mid 40s, there tends to be a bit of flexibility of how you interact compared to a guy who is probably 55 plus—maybe it's a different generation. It is a generation raised in the culture of hierarchy—a father is a father—you said, you know, *jumbo ssebo*, and then you look the other way, you know. So, I think that we also have to be fair to some of those social cultural issues within our context. **15SEM—Senior Leader**

This result seems to imply that the natural scientists' organisation may portray an affinity towards hierarchical, traditional authoritarian leadership given that it has such a large number of leaders 50 and older.

4.3 Objective 1: Contextual influences on leader development

Objective one seeks to identify the contextual influences on leader development, such as attitudes, beliefs, subjective norms, intentions, and experiences unique to natural scientist leaders in the Ugandan context.

Table 4.3 Determinants of leader development behaviour [a]

	Mean score by professional group			
	Scientists (n=93)	Non-scientists (n=96)	F	Sig.
Attitude	3.86	4.15	5.909	**0.016**
Outcome Expectations	4.47	4.51	0.268	0.605
Subjective Norms	3.83	4.00	3.409	0.066
Perceived Behaviour Control	4.00	4.35	11.530	**0.001**
Intention	3.91	4.25	17.211	**0.000**

a: Scale 1 (Strongly Disagree) -5 (Strongly Agree)

One-Way ANOVA and the F-test were used to examine the differences in perceptions between scientists and non-scientists. Table 4.3 above shows the mean scores on the determinants of leader development behaviour based on as per the theoretical framework. The mean scores were derived from Likert scales ranging from 1 to 5. The results show that within the scientists' group, *outcome expectations* were highest at 4.47, while the lowest-scoring determinant was *subjective norms* and *attitude*. The results also show that non-scientists rated higher on all determinants of leader development compared to scientists. However, only in three areas (*attitude*, *perceived behaviour control*, and *intention*) was there a statistically significant difference in the way scientists demonstrated beliefs and perceptions that drive participation in leader development activities. For example, when it comes to the attitude, which represents the perceptions towards participation in leader development activities and the value of leadership to technical personnel, the scientists scored a mean of 3.86.

In contrast, the non-scientists scored a mean of 4.15, which was statistically significant (p=0.016). On *intention*, which represents having deliberate and active plans to engage in specific activities to grow one's leadership skills, scientists scored a mean of 3.91, which was significantly lower than non-scientists at 4.25 (p<0.001). Similarly, scientists scored a mean of 4.00 compared to non-scientists mean score of 4.25, a statistically significant difference (p=0.001). These results are similar and corroborated with those from the qualitative interviews, where it was reported by the majority of the respondents that scientists approach leader development in a lacklustre manner and experience both real and perceived obstacles to leader development that are unique to their context. Specifically, medical doctors, for example, experience schedule and workload problems that make it practically difficult to participate in leader development activities. One respondent summarised this context problem as follows:

> Let's say you are working in a private hospital…what kind of rota system are you working on? If you're doing what I call a one-in-two, which means one night you're on, the other night you're off. Usually, the second night you are off, you're trying to sleep rather than study. But on the other hand, if you're provided with a rota which has at least a one-in-three, one-in-four, one-in-five, it means that there are certain nights that you can say "for me this night, I will read, or I can attend the Grand Round where some visiting professor is speaking. Now, these things are difficult…work is really, really busy. That extra pound of flesh that is expected from your employer can often come at the expense of your personal life. Let's say you have a young family. You've recently gotten married, and yet at the same time, you're trying to grow your career. Trying to learn something [non-technical and (mis)considered peripheral in the context] has to give. **2SMF-Senior Leader**

The implication of the results could be that while scientists may appreciate the benefits of leader development in comparable terms to non-scientists (for example, they scored about the same on *outcome expectations*), their attitude towards leadership and leader development activities, the limited active planning towards leader development, and the obstacles in their context that make them believe engaging in leader development is outside their control, all combine to create a disincentive to participate in leader development. For example, while promotion mainly focuses on technical skills and less on leadership skills, the technical qualification that matters most takes a very long time to attain. This phenomenon was well articulated by one of the participants in the scientists' FGD, as outlined below.

> For us scientists, the things that matter to your career are not administrative. First, you get into a leadership position because of your technical expertise, and your remuneration increases based on the research you undertake and publish, and the projects you lead. Delivering on that requires you to focus on the technical work. In that case, administrative work and being bogged down by managing people becomes immensely unattractive.…For example, to rise to my level, I was expected to have a PhD in crop science and to have published at least four major papers. That process takes time. Time you might not divide up to undertake a leadership course when you know that as much as such soft skills are helpful, they are not required for you to push ahead in your career. **FGD-Scientist-Male**

Regarding subjective norms, the results in Table 4.3 above could indicate that there was no significant difference between scientists and non-scientists. This could be surprising given that the literature on social identity theory and the results from the qualitative data seem to indicate a strong influence of context and norms among scientists such as medical professionals compared to non-scientists. Each determinant of leader development is considered in greater detail below, and comparisons are made between scientists and non-scientists to identify the unique areas of interest.

4.3.1 Attitudes

Several respondents across scientific disciplines attested to an attitude that elevates the technical, scientific skills as superior and belittles the value or necessity of leadership skills and soft skills in general. While this permeates all seniority and leadership responsibility strata, interviewees specifically highlighted this attitude to be more ubiquitous among early-career scientists and student scientists. The results seem to imply that given the premium value attached to the complicated, scientists such as medical doctors do not put in the effort to learn skills considered purportedly easy and, as one respondent put it, "for people who are intellectual penguins" (**4SMM-Senior Leader)**, unlike highly sophisticated scientists. This phenomenon is captured in the voice of this respondent below.

> I think it comes from the first or second year in medical school. Especially in the sciences, you're basically trained to think that you know better than everybody else. I recall, and you may know this, we used to call people who were not in medical school, 'penguins' [laughter] and the origin of that was that... The medical students many years ago used to boast that, you know, those guys in [humanities], they use textbooks from Penguin Books, you know, which was thought to be, you know, a publisher of books for children and that simplistic stuff. So somehow from just saying they use Penguin Books, which is not a problem at all, they coined the terminology of penguins, which is derogatory really, I mean, when you think about it, it has absolutely no relation to the ability and the contribution these guys are going to make in society. But it's an attempt to demonstrate that we are better. We are studying things which are more complicated and, you know, more hardcore. So, from that and the way the medical courses are structured, they don't even emphasise the need for those soft skills. They don't even [encourage leader development], like when you're in med school, at least in our time, you never even thought of yourself as a leader. You never thought that you need anything else. No one ever told you that 'by the way, as you go out, you may be made the head of a health facility and you'll be supervising human resources. Now, you need this to be able to do that well.' Never did anyone mention that. **4SMM-Senior Leader**

Specifically, for medical doctors, even after undergraduate medical school, participants mentioned that there remains an attitude (driven by a superiority leader self-view) that leadership outside of the technical, clinical environment is beneath the doctor unless it is at the highest levels of decision making such as national levels.

> Our attitude has been to our undoing. Just recently, we are waking up and opening up ourselves to people outside the sciences to come and speak to us. A recent example, because I did my nomination last week. So, I shared on my medical school WhatsApp group, my intention to run for political office as councillor [laughter]. You do not know what happened. Guys came up like 'No, that's a very low position, remember you have MBChB, you are a doctor, blah, blah. Oh, guys were really all out to say 'you man, get serious! How can you go so low?' But luckily enough, in that same group, there were other guys actually who had a different mind. Who were like, the sooner you doctors wake up and realise that actually just having the title MBChB is not what really brings you food on the table. And it's not what makes you relevant in society, the better. You know, so there has been an attitude problem, where feeling that because we were the A students in class, then we are on top of everybody else. And yet when you come back down to life what you need is money for children's school fees, a good house to shelter your family. And those things don't come because I am a doctor. Those things only come by my willingness to open myself up and networking with people from various classes of life. **8SMM-Middle Manager**

The implication of the results could be that, by seeing themselves in superior terms only befitting top positions in administration roles (especially for responsibilities outside of their scientific field), scientists may be reluctant to take on leadership roles and responsibilities. In contrast, the findings appear to show that non-scientist welcomed every opportunity to develop their leadership skills right from childhood and heightened the same during their undergraduate study, internship and early career experiences. Specifically, respondents among the non-scientist groups spoke fondly of their experiences as leaders in sports, community experiences, religious groups and school co-curricular activities, as having developed and strengthened their leadership 'muscles'. This was described by several respondents, as highlighted by the voices below.

> We haven't been looking at [leader development] in terms of maybe those [individuals] who have potential and those who don't have, because, again, I always say that the thinking is that everyone needs the opportunity to test what this leadership thing is, what leadership looks like. **22NHF—Middle Manager**

> I recognise that experience [of working in the community] as important. Then my second job was also equally challenging. I was working with the Ministry of Finance and we were assigned the work of rolling out the Integrated Financial Management System. For me, I was assigned to local governments, and you know local governments in the districts, they are not tech savvy people. Then you bring a project that is not very friendly. It's not really well received. You're dealing with people who are not tech savvy, with quite a challenging attitude and then you still have to deliver. So, for me, those experiences, (actually where I'm working now, I've not been faced with situations where I have to deliver under difficult circumstances), but because of the experience then, I find it is easy now to do some of these difficult things. And so indeed, those challenging opportunities would not appear challenging to me now because I have gone through them in my young career. They taught me early in my career and I learnt a lot. So, it's true, getting challenging assignments builds leadership. **23NTM—Senior Leader**

The restricting nature of the attitude scientists have to leader development was similarly manifested in the quantitative survey results. Table 4.4 below shows the descriptive statistics on items measuring attitude to leader development among the scientists in comparison to the non-scientists.

Table 4.4 Attitudes to leader development

Statements on Attitude	***Comparator Group***	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
Leadership decisions within a technical setting should be left to technical experts (r)	Scientist (n=91)	(17) 18.7%	(27) 29.7%	(9) 9.9%	(28) 30.8%	(10) 11%
	Non-Scientist (n=90)	(7) 7.8%	(30) 33.3%	(9) 10%	(34) 37.8%	(10) 11.1%
	Total (N=181)	(24) 13.3%	(57) 31.5%	(18) 9.9%	(62) 34.3%	(20) 11.0%
I am well informed about what a leadership position in my field requires	Scientist (n=91)	(1) 1.1%	(4) 4.4%	(7) 7.7%	(45) 49.5%	(34) 37.4%
	Non-Scientist (n=90)	(1) 1.1%	(0) 0%	(1) 1.1%	(39) 43.3%	(49) 54.4%
	Total (N=181)	(2) 1.1%	(4) 2.2%	(8) 4.4%	(84) 46.4%	(83) 45.9%
Opportunities for technical experts to develop managerial/leadership skills should be promoted widely	Scientist (n=91)	0 (0.0%)	(2) 2.2%	(1) 1.1%	(24) 26.4%	(64) 70.3%
	Non-Scientist (n=90)	0 (0.0%)	(2) 2.2%	(3) 3.3%	(32) 35.6%	(53) 58.9%
	Total (N=181)	0 (0.0%)	(4) 2.2%	(4) 2.2%	(56) 30.9%	(117) 64.6%
I already have the skills needed to lead; no further leadership development is needed (r)	Scientist (n=91)	(2) 2.2%	(10) 11%	(17) 18.7%	(44) 48.4%	(18) 19.8%
	Non-Scientist (n=90)	(0) 0%	(9) 10%	(6) 6.7%	(48) 53.3%	(27) 30%
	Total (N=181)	(2) 1.1%	(19) 10.5%	(23) 12.7%	(92) 50.8%	(45) 24.9%
Getting good in leadership skills is not as important as getting good in technical competencies (r)	Scientist (n=91)	(6) 6.6%	(4) 4.4%	(10) 11.0%	(35) 38.5%	(36) 39.6%
	Non-Scientist (n=89)	(1) 1.1%	(3) 3.4%	(6) 6.7%	(40) 44.9%	(39) 43.8%
	Total (N=180)	(7) 3.9%	(7) 3.9%	(16) 8.9%	(75) 41.7%	(75) 41.7%

Numbers in parentheses denote frequency (n), Statements with (r) denote statements reversed during analysis. Percentages may not add to 100% due to rounding.

The results in Table 4.4 above seem to confirm the sentiments in the qualitative interviews. On the reversed item ‘I already have the skills needed to lead; no further leadership development is needed’, nearly a third of the scientists (31.9%) did not reject this supercilious notion in comparison with only 16.7% of non-scientists. Moreover, only 19.8% of scientists strongly rejected the notion compared to 30% of non-scientists. The qualitative interviews resonate with and explain this finding. Specifically, several medical doctors and two crop scientists interviewed highlighted that their technical qualifications automatically bestow on them the qualifications and right to lead since they would be the most senior technical person on a team. The implication is that if a scientist is good in relation to technical skills, they perceive themselves to be a leader or at least to qualify for leadership positions even though they may not have engaged in any leader development activities.

> So, the fact that the environment in which you are trained and of course, even our apprenticeship while on the wards, the senior consultant is seen as the king when they say ‘bring this’ people bring it. When they say ‘discharge this one’, they discharge, when they say, ‘put this one on the theatre list’, they put them like there is no negotiation. You’re not trying to seek understanding. You’re not trying to show these medical students how to deal with people, how

to understand the feelings of people apart from a very few people who were especially trained from abroad. So, I think the training environment really moulded us to think in a certain way and particularly to consider those soft skills irrelevant, actually, first of all, to be ignorant about them and then not appreciate them. Even when we had an opportunity until very late, others barely appreciate their value anyway. **4SMM—Senior Leader**

Similarly, scientists scored lower than non-scientists on the perception that 'Getting good in leadership skills is not as important as getting good in technical competences' with only 78.1% of scientists rejecting the idea of getting better at leadership not being as important as improving one's technical competences compared to 88.7% non-scientists who rejected that premise. In addition, on the notion of leadership decisions in a technical environment being a preserve of the technical experts, more scientists agreed to that position compared with non-scientists, with 18.7% scientists strongly aligning compared to only 7.8% non-scientists aligning strongly. However, the results indicate that on other dimensions of attitude, such as the need to promote leader development opportunities widely or knowing what leadership positions require, scientists were comparable to non-scientists.

4.3.2 Beliefs on outcome expectations

Table 4.5 below shows the results on the beliefs that different leaders hold towards leader development.

Table 4.5 Beliefs on outcome expectations of leader development

Statements on Outcome expectations	***Comparator Group***	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
Participating in leader development activities is essential for me to excel in my work	Scientist (n=91)	(0) 0%	(0) 0%	(3) 3.3%	(37) 40.7%	(51) 56.0%
	Non-Scientist (n=90)	(2) 2.2%	(0) 0.0%	(1) 1.1%	(18) 20.0%	(69) 76.7%
	Total (N=181)	(2) 1.1%	(0) 0.0%	(4) 2.2%	(55) 30.4%	(120) 66.3%
Developing my leadership skills will enable me to take on senior leadership roles in my career	Scientist (n=91)	(0) 0%	(0) 0%	(5) 5.5%	(32) 35.2%	(54) 59.3%
	Non-Scientist (n=90)	(2) 2.2%	(0) 0%	(1) 1.1%	(18) 20.0%	(69) 76.7%
	Total (N=181)	(2) 1.1%	(0) 0%	(6) 3.3%	(50) 27.6%	(123) 68.0%
It is important for technical experts to have managerial/leadership responsibilities	Scientist (n=91)	0 (0.0%)	(1) 1.1%	(7) 7.7%	(21) 23.1%	(62) 68.1%
	Non-Scientist (n=89)	3 (3.4%)	(4) 4.5%	(5) 5.6%	(29) 32.6%	(48) 53.9%
	Total (N=180)	3 (1.7%)	(5) 2.8%	(12) 6.7%	(50) 27.8%	(110) 61.1%
Individuals with training and experience in leadership are more likely to get results for their technical teams	Scientist (n=91)	(1) 1.1%	(3) 3.3%	(8) 8.8%	(30) 33.0%	(49) 53.8%
	Non-Scientist (n=89)	(1) 1.1%	(1) 1.1%	(8) 9.0%	(25) 28.1%	(54) 60.7%
	Total (N=180)	(2) 1.1%	(4) 2.2%	(16) 8.9%	(55) 30.6%	(103) 57.2%
The more one participates in leadership development activities, the more likely for them to be effective in leading technical teams	Scientist (n=91)	(0) 0.0%	(3) 3.3%	(10) 11.0%	(30) 33.0%	(48) 52.7%
	Non-Scientist (n=90)	(1) 1.1%	(3) 3.3%	(7) 7.8%	(28) 31.1%	(51) 56.7%
	Total (N=181)	(1) 0.6%	(6) 3.3%	(17) 9.4%	(58) 32.0%	(99) 54.7%

Numbers in parentheses denote frequency (n), Statements with (r) denote statements reversed during analysis. Percentages may not add to 100% due to rounding.

As seen in Table 4.5, the results appear to indicate that most leaders believe that participating in leader development activities is essential for their work. Nonetheless, non-scientists more strongly agreed to holding such a belief (76.7%) compared to scientists (56%). This was similar to the perception that engaging in leader development enables one to take on senior leadership roles. More non-scientists strongly agreed (76.7%) compared to scientists (59.3%). Furthermore, many scientists believe that effective leadership is important for technical experts and brings results, with 91.2% agreeing it is important for them to have leadership responsibilities, 86.8% agreeing it helps to deliver results and 85.7% agreeing that more leader development leads to better leadership effectiveness. The findings from the qualitative interviews confirm these results. Most scientists interviewed believed that participating in leader development activities is relevant for their overall effectiveness since their highly logical scientific training does not cover soft skills. This sentiment is captured by this leader from the Ministry of Agriculture.

> NARO is the most educated organisation in this country. Everybody is a doctor or is trying to be a doctor in one way or another, you know, so it's really a very, very scientific organisation in whatever they do. And probably that may be a challenge because it's made up of scientists and not probably managers or leaders, but they have to convert to become leaders. All of us do that…. Managing people is the one which is very challenging. There's no straight formula; it's not one plus one equals two. As a crop scientist, I did not go anywhere to learn management or leadership, so we really just have to learn management on the job, which sometimes I think is not very easy. You know, when you come into a job, you are, you know, very technical, but then you have to start managing people, start managing resources, you know, and that is usually very, very difficult for us who are not, you know, in that field. But basically, the learning is just through experience. As a team leader in a very technical job, I had to start taking on the roles of management and leadership, eventually learn certain skills, you know, on managing people, which is one of the most difficult…. if you're just a pure researcher who works alone, maybe with one lab technician, it may not be necessary. But in life, I can tell you very clearly, everybody works with somebody or everybody supervises somebody. So, these skills cannot be ignored, but scientists usually, especially when they are coming out of university and they're just starting research, they feel those are not necessary skills. But as you begin to climb up the ladder, every scientist will eventually climb up the ladder and start to manage more people, you definitely need those skills whether you like it or not. **18SAM—Senior Leader**

> I believe that the non-scientists believe more in taking initiative to develop their leadership skills because it actually pays in developing their career. At URA, for example, people can easily see that they will be promoted on the basis of their ability to lead and influence teams better to perform, not just number of years spent in service or technical qualifications. Here,

> even a young person stands chances of being promoted to head a unit if they have what it takes, unlike the scientists at MAAIF where you must have spent many years to prove your technical competence. Even more, in URA, at the application stage, some positions require that you prove you have been trained in leadership. So, this forces people to take leadership training seriously. **FGD—Non-scientist—Female**

The results seem to imply that whereas many scientists see the value of leadership development and can link leader development to career progression, they are not emphatic enough to strongly connect that line of sight, perhaps signifying that other contextual influences might determine career progression. The findings also might explain why even though many scientists believe in the relevance and effectiveness of various leader development approaches, few report regularly participating in them (see section 4.5 and 4.6).

4.3.3 Subjective norms

This section aimed to identify deeply held social identities and group expectations among scientists that impact leader development or leadership effectiveness. Several respondents interviewed highlighted the subjective norms that impact the way leader development is approached. These included a culture where peers put pressure on others to master technical skills as the sure way for career progression with little encouragement given for leadership skills development. This experience cut across scientific disciplines, including medicine, agriculture, and engineering.

Furthermore, besides the undergraduate school curriculum for agriculturalists, engineers or medical doctors not including leadership modules, interviewees recounted how the scientists' undergraduate programmes are so elaborate and occupy one's time in ways that make it difficult for students to involve themselves in co-curricular or social activities. Some of the respondents reported having experienced a significant decline in academic performance by participating in co-curricular activities—a costly trade-off, albeit one that they perceive to have been worthwhile. Nearly all the respondents attributed their leader development experiences to personal ambition and drive which enabled them to undertake additional activities (that ended up nurturing their leadership skills), often non-typical for natural science students or early-career practitioners. There is a strong subjective norm that good doctors, engineers or agronomists and those that would like to be great, focus on the technical skills development path. Moreover, in the case of the medical doctors, given the resource-constrained setting, it is often that the doctor is overwhelmed with work that if there could be any additional time available to take on a new course, it would be prioritised for technical skills such as an MMed programme than a leadership programme.

One of the subjects that we were taught in school had just been introduced into medical school, and that was bedside manners if we can call it that, it was really all about people skills… But can I tell you what? We never, ever had direct training on leadership or management… personally, I think my leadership roles really started way back when I was in [high] school, as a school prefect…and at the university, I was leading the Christian Union…so you gain some experience from other leadership opportunities **1SMF—Senior Leader**

We really never get to learn those people skills. You know, even if you know that there are some broad courses where they touch on a few things once in a while. But for a scientist, it is either chemistry, biochemistry, biology, which does not have anything to do with leadership. Some of those skills are not factored in the way we are trained or how we are promoted. For example, I can say scientists usually want to give the most technically qualified person the highest position. In NARO, for example, it's a condition that if you don't get a doctorate after a certain time, you may not continue with the organisation, you get it? I think it is the policy. So, you will go to NARO and find that everybody is trying to progress in the scientific field so that they can be able to get the learning and knowing so much about very little. A person has a PhD in a disease of a plant root of only a certain type of plant. So, for one to focus so much on this specific scientific work takes time and they tend to forget the other parts of the world. The problem is that scientists don't really think those other soft skills are important for them because all they are looking at is professional academic progression. **18SAM—Senior Leader**

Table 4.6 Subjective norms on leader development

Statements on Subjective norms	***Comparator Group***	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
Most people who are important to me think that I should participate in leadership development activities	Scientist (n=91)	(1) 1.1%	(9) 9.9%	(17) 18.7%	(44) 48.4%	(20) 22.0%
	Non-Scientist (n=89)	(1) 1.1%	(5) 5.6%	(20) 22.5%	(38) 42.7%	(25) 28.1%
	Total (N=180)	(2) 1.1%	(14) 7.8%	(37) 20.6%	(82) 45.6%	(45) 25.0%
It is expected of me to participate in leadership development activities	Scientist (n=91)	(1) 1.1%	(3) 3.3%	(7) 7.7%	(50) 54.9%	(30) 33.0%
	Non-Scientist (n=90)	(0) 0.0%	(1) 1.1%	(12) 13.3%	(43) 47.8%	(34) 37.8%
	Total (N=181)	(1) 0.6%	(4) 2.2%	(19) 10.5%	(93) 51.4%	(64) 35.4%
My peers believe that participating in leadership development activities is important	Scientist (n=91)	(0) 0.0%	(1) 1.1%	(13) 14.3%	(57) 62.6%	(20) 22.0%
	Non-Scientist (n=90)	(0) 0.0%	(1) 1.1%	(11) 12.2%	(54) 60.0%	(24) 26.7%
	Total (N=181)	(0) 0.0%	(2) 1.1%	(24) 13.3%	(111) 61.3%	(44) 24.3%
Most technical experts I know regularly participate in leadership development activities	Scientist (n=91)	(4) 4.4%	(23) 25.3%	(22) 24.2%	(35) 38.5%	(7) 7.7%
	Non-Scientist (n=90)	(2) 2.2%	(15) 16.7%	(28) 31.1%	(29) 32.2%	(16) 17.8%
	Total (N=181)	(6) 3.3%	(38) 21.0%	(50) 27.6%	(64) 35.4%	(23) 12.7%
It’s normal for people like me to regularly engage in leadership development activities	Scientist (n=91)	(3) 3.3%	(7) 7.7%	(12) 13.2%	(40) 44.0%	(29) 31.9%
	Non-Scientist (n=89)	(0) 0.0%	(4) 4.5%	(8) 9.0%	(36) 40.4%	(41) 46.1%
	Total (N=180)	(3) 1.7%	(11) 6.1%	(20) 11.1%	(76) 42.2%	(70) 38.9%

Numbers in parentheses denote frequency (n), Statements with (r) denote statements reversed during analysis. Percentages may not add to 100% due to rounding.

Table 4.6 above highlights the results on subjective norms from the quantitative phase of the study. The results seem to show that overall, there is strong support for leader development amongst the scientists’ community, albeit it is much stronger among non-scientist. Most scientists (70.4%) agree that most people who are important to them expect them to participate in leadership development activities, which is comparable to the non-scientist’s perceptions (70.8%). Similarly, most scientists (87.9%) agree that it is expected of them to participate in leader development, and an equally high number agrees that their peers believe that leader development is important (84.6%). This was comparable to non-scientist who scored 85.6% and 86.7%, respectively. Notably, the results seem to show that a higher proportion of non-scientist (17.8%) strongly agree that technical experts they know engage in leader development compared to scientists (7.7%). Moreover, only 31.9% of scientists strongly agree that engaging in leader development is a norm for people like them compared to 46.1% among non-scientist. The implication of the results is that while there seems to be support and acceptance of the importance of leader development among scientists, actual engagement in these activities is not such a strongly held norm in comparison to non-scientists, perhaps due to other contextual factors—a phenomenon that the qualitative interviews aptly explain as discussed above and is discussed further in the next sections.

4.3.4 Perceived behaviour control

This section sought to establish the extent to which natural scientists consider participation in leader development to be within their control and what makes it easy or difficult for them to engage in leader development. Perceptions were then compared with those of non-scientists.

Table 4.7 Perceived behaviour control on participating in leader development

Statements on perceived behaviour control	***Comparator Group***	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
I am confident that I could develop my leadership capacity if I wanted to	Scientist (n=91)	(0) 0.0%	(4) 4.4%	(8) 8.8%	(41) 45.1%	(38) 41.8%
	Non-Scientist (n=90)	(1) 1.1%	(1) 1.1%	(5) 5.6%	(33) 36.7%	(50) 55.6%
	Total (N=181)	(1) 0.6%	(5) 2.8%	(13) 7.2%	(74) 40.9%	(88) 48.6%
For me to regularly participate in leader development activities is impossible (r)	Scientist (n=90)	(4) 4.4%	(5) 5.6%	(3) 3.3%	(44) 48.9%	(34) 37.8%
	Non-Scientist (n=90)	(2) 2.2%	(4) 4.4%	(8) 8.9%	(40) 44.4%	(36) 40.0%
	Total (N=180)	(6) 3.3%	(9) 5.0%	(11) 6.1%	(84) 46.7%	(70) 38.9%
The decision to develop my leadership capability is beyond my control (r)	Scientist (n=90)	(5) 5.6%	(5) 5.6%	(7) 7.8%	(38) 42.2%	(35) 38.9%
	Non-Scientist (n=89)	(3) 3.4%	(4) 4.5%	(5) 5.6%	(37) 41.6%	(40) 44.9%
	Total (N=179)	(8) 4.5%	(9) 5.0%	(12) 6.7%	(75) 41.9%	(75) 41.9%
Leadership is for people like me	Scientist (n=89)	(8) 9.0%	(11) 12.4%	(12) 13.5%	(30) 33.7%	(28) 31.5%
	Non-Scientist (n=90)	(1) 1.1%	(3) 3.3%	(10) 11.1%	(32) 35.6%	(44) 48.9%
	Total (N=179)	(9) 5.0%	(14) 7.8%	(22) 12.3%	(62) 34.6%	(72) 40.2%
It is not difficult for me to participate in leadership development activities	Scientist (n=90)	(0) 0.0%	(8) 8.9%	(11) 12.2%	(35) 38.9%	(36) 40.0%
	Non-Scientist (n=90)	(2) 2.2%	(1) 1.1%	(6) 6.7%	(37) 41.1%	(44) 48.9%
	Total (N=180)	(2) 1.1%	(9) 5.0%	(17) 9.4%	(72) 40.0%	(80) 44.4%

Numbers in parentheses denote frequency (n), Statements with (r) denote statements reversed during analysis. Percentages may not add to 100% due to rounding.

Table 4.7 shows the results on the perceived behaviour control among scientists and non-scientists. The results appear to indicate that both scientists and non-scientists have a strong self-efficacy when it comes to leader development. Most scientists (86.9%) expressed confidence that they could develop their leadership capacity if they wanted to, which was comparable to the non-scientists who scored slightly higher at 92.3%, the proportion that agrees. Similarly, 78.9% of scientists agreed that it is not difficult to participate in leader development activities compared to 90% of non-scientists. The results also show that nearly two-thirds of scientists agreed that leadership is for people like them (65.2%) compared to 84.5% of non-scientists.

Moreover, with 9% of scientists strongly disagreeing with the statement that ‘leadership is for people like me’ compared to 1.1% of non-scientists, the implication of the results could be that the conceptualisation of leadership among scientist is different from that of the non-scientists. This view of leadership being a somewhat alien phenomenon to some scientists was frequently referenced by the participants in the qualitative interviews.

> I don't remember attending any leadership class at the University. None. So, it was purely the way the chemicals react to each other and doing things in test tubes. As for a human face to what we do, we've learnt on the job. Having a mentor who is intentional in helping your learn leadership and influencing people is critical for a scientist…The biggest challenge I've seen, you're having brilliant scientists, but they are not good at relating with others. A typical scientist wants to agree on something in a meeting, and then you just wait until the output is out and then don't ask them anything else. Last week I was dealing with a famous scientist in Uganda—seasoned and senior. He was given a contract to go and train some people on how to manage fertilisers. On reaching the field, he struggled and came back to our office to help him saying that 'these guys are giving me a hard time.' So, I told him, 'you've been in the research lab all this time, only caring about producing your seed varieties, you think that is all there is to it. But how you relate to field teams and influencing them to listen to you, is important. Now us with very limited qualifications are the ones helping you to sweet talk those people to do what they are supposed to do.' I think that is where we are having our biggest challenge as scientists. For me I was lucky to get a mentor. Leadership is not something we think much about in our field. We learn from the job. So, if you don't have a good mentor, it becomes complicated. **19SAM—Frontline Leader**

> I think the mentality of scientists is that science is very complex and hard. Even back then when we were at the University, you would introduce yourself as a scientist, and you would be respected. So, if you are doing complex things, you don't have time to do these things of networking…So we find people trivialise meetings, networking, connecting, and yet, as you rise up in the career, you find out, in reality, even getting grants boils down to someone's networks. **20SEM—Middle Manager**

Nonetheless, as seen in Table 4.7, the results seem to show that despite the perception by nearly one-third of scientists not agreeing that leadership is for people like them, the majority of scientists disagree that the decision to engage in leadership is beyond their control (81.1%). Moreover, 86.7% disagree that it is impossible for them to engage in regular leadership development activities. The results imply that, indeed as some participants suggested, scientists have a high leader learning efficacy, believe in their ability to learn leadership and could participate if they wanted to.

Many of the respondents bemoaned the numerous barriers that impede participation in leader development activities even if one wanted to. In the case of medical doctors, for example, right from medical school, the time available to a medical student to engage in extracurricular or social activities as a means to develop soft skills is limited. Even after graduation, resource-constrained settings like Uganda mean that doctors are overworked and underpaid, making it difficult for leadership training to have a meaningful share of wallet and time. Moreover, several respondents said that many healthcare organisations are just beginning to see the value of leadership development. At the moment, every doctor is left to themselves to figure out how to learn leadership—usually through trial and error.

> As an MMed student, it is structured within your work life that you will have lectures, and you will have times to discuss. You will because you're in a programme and you have to read. So, if you get on a programme, then it becomes easier. If, however, you're not in a programme. And let's say you are working in a private hospital. Then it depends on what the attitude of the leaders is towards personal development in terms of how, for example, what time-off you'll get to maybe even pursue your own studies or do they provide continuing medical education? Or is there Internet and availability? **2SMF—Senior Leader**

> At the University, I stood for elections of the student's guild, I participated in outreach missions, sports and was even an acting headteacher for a community school during holidays…but I ended up failing in some of my medical exams and took a dead-year…even struggled through depression. The opportunity to engage in leadership activities are many if you wanted to, but the challenges are so many that you would rather concentrate, on medical education than engaging in either student leadership or mission activities. The medical curriculum is very demanding such that even after class, you are expected to stay hours-on-end with classmates in discussion groups or practicals. **8SMM—Middle Manager**

Some participants suggested that another aspect of why it may be difficult for scientists to engage in leader development activities to the extent that they want to is their perceived lack of influence within the broader organisational structure where non-scientists manage the administration and resources. The inability to articulate the need and influence the allocation of resources is something one key informant specifically spotlighted, as evidenced in the quote below.

> When you come to MAAIF, there are people who think, 'ah! Those are scientists, we are the planners, we know best about leadership.' Administration feels, we're administration, we know best. Yes you are administrators but you're not giving room to scientists to exercise freedom in working how they are programmed, using the money that is available... so we hold meetings, but when you hold meetings and you never have the resources…skills such as galvanising a

team, listening are important, but influence is perhaps the most important because when you cannot influence and negotiate to find the resources, then you find you don't have the power. You have engineers or VETs, and their hierarchy, they articulate what they have to do, and they have brilliant ideas…but if you can't influence the system, you can't do much in terms of resources. **13SEM—Senior Leader**

4.3.5 Intention

This section was aimed at identifying the levels of intent to participate in leader development activities among scientists. Table 4.8 shows the level of agreement with statements linked to intention to participate in leader development.

Table 4.8 Intention on participating in leader development

Statements on Intentions	*Comparator Group*	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
I plan to participate in leadership development activities on a regular basis	Scientist (n=91)	(0) 0.0%	(4) 4.4%	(17) 18.7%	(51) 56.0%	(19) 20.9%
	Non-Scientist (n=89)	(0) 0.0%	(3) 3.4%	(7) 7.9%	(47) 52.8%	(32) 36.0%
	Total (N=180)	(0) 0.0%	(7) 3.9%	(24) 13.3%	(98) 54.4%	(51) 28.3%
I would like to have had more management/leadership training during undergraduate training	Scientist (n=91)	(1) 1.1%	(7) 7.7%	(8) 8.8%	(43) 47.3%	(32) 35.2%
	Non-Scientist (n=90)	(1) 1.1%	(11) 12.2%	(11) 12.2%	(38) 42.2%	(29) 32.2%
	Total (N=181)	(2) 1.1%	(18) 9.9%	(19) 10.5%	(81) 44.8%	(61) 33.7%
I will seek additional leadership/management training in my further studies	Scientist (n=91)	(0) 0.0%	(2) 2.2%	(11) 12.1%	(53) 58.2%	(25) 27.5%
	Non-Scientist (n=89)	(0) 0.0%	(0) 0.0%	(3) 3.4%	(45) 50.6%	(41) 46.1%
	Total (N=180)	(0) 0.0%	(2) 1.1%	(14) 7.8%	(98) 54.4%	(66) 36.7%
I plan to set aside time and resources to engage in activities that help me become a better leader	Scientist (n=90)	(1) 1.1%	(0) 0.0%	(8) 8.9%	(46) 51.1%	(35) 38.9%
	Non-Scientist (n=89)	(0) 0.0%	(0) 0.0%	(1) 1.1%	(31) 34.8%	(57) 64.0%
	Total (N=179)	(1) 0.6%	(0) 0.0%	(9) 5.0%	(77) 43.0%	(92) 51.4%
I have a personal development plan for my leadership skills outlining which activities I will engage in for the next 3 months	Scientist (n=91)	(6) 6.6%	(13) 14.3%	(27) 29.7%	(34) 37.4%	(11) 12.1%
	Non-Scientist (n=88)	(0) 0.0%	(12) 13.6%	(23) 26.1%	(28) 31.8%	(25) 28.4%
	Total (N=179)	(6) 3.4%	(25) 14.0%	(50) 27.9%	(62) 34.6%	(36) 20.1%

Numbers in parentheses denote frequency (n), Statements with (r) denote statements reversed during analysis. Percentages may not add to 100% due to rounding.

The results seem to show that most scientists plan to participate in leader development activities regularly (76.9%), which is comparable with non-scientists (88.8%). However, the strength of agreement was slightly higher among non-scientists, with 36% non-scientists strongly agreeing that they plan to participate regularly compared to only 20.9% of scientists who strongly agree. Moreover, 46.1% of non-scientists strongly agreed that they would seek additional leadership training in further studies compared to 27.5% of scientists that strongly agreed. Both scientists (82.5%) and non-scientists (74.4%) have high proportions that agree to the need to have had more leadership training included in their undergraduate studies, albeit a higher proportion of scientists expressed such sentiment. Similarly, more non-scientists (64%) than scientists (38.9%) expressed strong agreement that they plan to set aside time and resources to engage in activities that nurture their leadership skills. Interestingly, the results indicate that having a personal development plan to develop one's leadership skills is not a widely adopted practice for both groups. Only 49.5% of scientist agreed to having such a development plan compared to 60.2% among non-scientists, demonstrating how much deliberate practice and intentionality is not typical.

Nonetheless, the qualitative data shows that for most participants, a high degree of self-motivation and ambition was a driving factor for them to have navigated challenges and subjective norms to engage in leader development activities. Several participants highlighted how, in rising to the top of their leadership career, they had demonstrated nonconformist behaviour, unlike their counterparts. This is consistent with what other studies have found; that developmental readiness and leader characteristics have a strong bearing on the appetite for, and the ability to benefit from, leader development (Hall, 2004; Avolio and Hannah, 2008; Hannah *et al.*, 2008; Reichard *et al.*, 2017). Several participants highlighted that taking on courses such as the Master of Public Health opened their eyes to the importance of leadership skills. A few just happened to enjoy being part of community, social, religious and sports leadership activities from which they recognised having learned many leadership skills, even though this was not through deliberate practice. Many reported that in the '70s and early '80s, Uganda used to send graduate doctors for specialised training in management before they were deployed in hospitals but that this has since been disbanded.

> I got involved in leadership since high school when I was the captain of the basketball team, which won several championships. I was also a prefect for sports. I then went to get several positions while at University. Of course, I was the secretary for health. Then became the chairman of [hall of residence—*redacted*]. Simultaneously, I was the President of my OBs association, the campus chapter. Now, I went on to become the class representative of my master's class at the [University—*redacted*]. Then I was the vice-chair and later chair of the village where I live. And of course, I have been involved in the leadership of the medical association…What are the success factors? What are the secrets? There are no secrets. It's about being determined as a leader…I think when it comes to scientists, what I can say is that we learn by doing and we are very, very prone to error. If you look at our hospitals, they are such that now even non-doctors are being brought on board to run the hospitals. I think it could be a function of our training where we are not trained to be leaders in the administration. Obviously,

we are going to be leaders in the medical aspects, but not in the administration of hospitals and human resources. **9SMM—Senior Leader**

There used to be a course at UMI soon after you finished medical school. It was very instrumental in preparing the doctors for leadership and management before they get into upcountry hospitals where they have to lead. It is, unfortunately, not there anymore. It is now baptism by fire. **7SMF—Senior Leader**

4.3.6 Other contextual influences

This section aimed to identify other themes within the qualitative interviews that depict aspects of the context, such as industry experiences, social identity, leader characteristics, organisational culture and practices that affect the learning of leadership among scientists. These and other emerging themes are presented below.

4.3.6.1 Leadership conceptualised as technical authority

Many of the respondents did not see themselves as leaders in their early life experiences or early careers and often found themselves thrust into the 'deep end' as they were expected to lead, simply because they held the senior-most position in the technical qualifications hierarchy. For many, leadership was conceptualised as positional and drawn from authority and technical expertise, whereby lower-ranking officers were expected to do the bidding of the higher-ranking officers. Therefore, the drive to have more substantial influence was fulfilled by putting in the hours and effort to be the most qualified technical person. Moreover, this conceptualisation of leadership as 'technical authority' was accentuated by Ugandan culture and power distance. The older, more technically qualified person was expected to provide leadership. At the same time, the followers were willing to fall in line, thereby precipitating a context where the value of soft skills such as persuasion, negotiation, listening, humility and other people skills would take a back seat as levers of influence, until recently when the authoritarian model is tending to be dumped in favour of the collaborative approach (which is billed to be more suited to solving complex interdisciplinary problems facing today's scientific world). In line with the implicit leadership theory, this finding implies that leaders who conceptualise leadership as technical authority might pay lip service to the impetus for leader development while focusing and investing in honing their technical skills. This was well articulated by one medical doctor, as recounted below.

So as far as the medical field and leadership is concerned, the people will listen to a leader because he has experience, because he has shown integrity and technical skill. Really, and if I wanted to be a leader in a medical field, I look after my technical knowledge, I make sure that I've done research and published. When I'm a surgeon, the patients are well taken care of, they get you excellent outcomes such that my rate of healing is high so that you can say, 'oh, if you go to Dr [*name redacted*], you have no problem. She will sort you out.' In that way I will lead, and you've heard the phrase, 'she's a leading authority in the field', that is leadership for us. So, when you are an authority and you talk and tell us do ABC, we will listen. And that authority is not because you have political prowess, but because your technical knowledge is superb, and the skill you use in practice is excellent. And because the skill is excellent it is interpreted as integrity. **1SMF-Senior Leader**

4.3.6.2 Leadership as hierarchical 'percussion'

In the case of medical scientists, interview data shows that the conceptualisation of superior technical qualification as leadership and the behaviour of the seniors pulling titles, positions and ranks as levers of influence was reported as a culture passed down to medical professionals right from medical school by the way professors treated their students and how students observed senior medical officers behave during the medical internship as recounted by one respondent below.

> I entered Makerere University as a lecturer, and I was working among the medical wards, and we had senior physicians there, and the way they taught is the way they had been taught, and we used to call it 'percussion', percussion is an approach that you can use when you are examining somebody's chest where you actually tap; I don't know if you've experienced this when your doctor puts his finger on your chest and taps to actually hear the hollowness that should be there in your chest, to see what is normal or abnormal, but that percussion is the application of pressure to something. And we as medical students, as junior doctors would say that 'Huh! That senior professor! He percusses you on the ward to make you bring out answers. So, you are on a ward round, you're standing around a patient's bed, and he shouts at you [loud authoritarian tone] 'Jane Doe [*name changed*], tell us the causes of an enlarged liver.' So, Jane shaking in her boots comes out with some kind of answer... Students sweating and trying to remain at the back of the crowd so that they don't get percussed. Now, when it comes to them teaching other students or teaching their juniors, they would use the same techniques of percussion. Yet that fear and the frustration that comes with it, I do not believe is the best way of learning or leading. **2SMF—Senior Leader**

As the participant above highlights further, this was different from their experience in the UK, where their professors adopted a collaborative, coaching approach.

> When I came back to Uganda, having trained in the UK as a physician and having worked there for about four years before I returned home…And so my mode of learning, what I learned from my professors in the UK was asking questions in a way to draw out the person's thinking and to make them happy that they found a solution rather than humiliating them in front of everybody else. Here in Uganda, those [percussion] are some of the habits that we pick up, and unfortunately, we pass it on to future generations. **2SMF—Senior Leader**

According to some interview participants, such a view of leadership is often challenged once the natural scientist leaders find themselves in multi-disciplinary teams or positions where they have to negotiate and collaborate with non-scientist leaders, who may not easily fit anywhere within their medical, agricultural or engineering qualifications pecking order. As one participant shared an experience where they were frustrated as a young doctor who had been put in charge as the District Health Officer (responsible for the health sector in the district) by virtue of being a medical officer but was struggling to negotiate and advocate for health priorities with local politicians who he thought lacked the mental capacity to understand health issues—yet these local leaders were his bosses.

> So, you find that you have to bend low and persuade people who never studied biology or chemistry and lack the basics of health care. And in my mind, I am like, 'why should I be negotiating with this fool', he should just understand that what I am telling him are the facts. **4SMM—Senior Leader**

However, this attitude of the ranking officer having 'legitimate' power to 'percuss' those below them ostensibly because they are senior was not limited to scientists. Several non-scientists highlighted this authoritarian leadership style as being common among non-scientist leaders, particularly the older generation, those who have not been open to feedback, are not self-aware or have not participated in leader development activities that heighten their understanding of the value of collaborative leadership.

> I can tell you that we have made tremendous improvements. We have leaders that listen, senior leaders that are accessible. I am a lower level supervisor but I can reach my Commissioner any time. I can email them; even send them WhatsApp and we interact. This is not the case in many other organisations. Even at URA, it never used to be that way. It began by our former Commissioner General, Allen Kagina, insisting on a different leadership approach. She would come to visit a station and when you address her as Madam CG, she says, 'No, call me Allen'. You feel very uncomfortable—'I call you Allen?' And she would say, 'Yes, I am Allen. The other one is a position.' Mm. That thing disorganises you, but indeed, as soon as you mention the name Allen, you also feel now, the fear has gone away and you can relate with her easily. But we have other leaders who behave like they are gods. As if to say you must call them

madam, or even kneel down. You get it? And now, the more leaders we're bringing on board, especially younger people, those ones are OK when it comes to traits in leadership. The more old the people, the more rigid they are. **25NTM—Frontline Leader**

Nonetheless, five participants within the scientists' group discussed this phenomenon in comparison to non-scientists and observed that the African cultural context, governance history and consequential power distance culture, is exacerbated by the tradition of the superiority of ranks within the natural scientists' community, making it a much bigger problem to address than non-scientists would face. Specifically, two participants linked this reluctance to listen to lower-ranking officers and the high power distance to a legacy of colonialism, whereby the existing education system for natural scientists may not have been designed to produce leaders but excellent technical professionals.

So, our culture says 'obey the high rank'. It's both in the non-sciences and in the natural sciences. Obey the high rank, and if you don't agree with the high rank, it's more like, remember the boss is right. And if the boss is wrong, remember, the first rule [laughter]—that is part of the colonial legacy. Now, when the Africans took over leadership, they assumed leadership in place of the colonial master. And it is played out consistently in our communities that the man at the top knows it all. For example, in Uganda, the President is the one that is consulted on everything. And he's the one that if he says that this is wrong, everybody, regardless of their technical know-how cannot dissent. If they did, it may come at a very expensive price. So, I think that the legacy of colonialism is doing what the master bids. So, at that point, soft skills were not necessary. We have maintained that heritage for the most part. The West may have discovered that that's not sustainable and they are turning around to train their scientists a bit differently. **3SMM—Senior Leader**

The ability to welcome differing views, especially from those below you, to welcome critiquing and criticism is very, very healthy. I believe in it personally, but it is not very well provided for in the MAAIF structures and how leaders behave. Of course, we conduct meetings and people are called to give their views but the mindset and the air around is that the Commissioner knows and the Commissioner wants A,B,C or the Director says A,B,C,D. So, there is a limited emphasis on free back and forth communication and little room for challenging each other. If we are to improve our leadership, this is perhaps an area for emphasising. In the level of importance, I would give it a nine out of ten. **17SAM—Senior Leader**

The African understanding of leadership and how that also reflects in maybe that militaristic style of hierarchy within the natural sciences…because even if you look at nurses, for example, they have chips on their shoulder and tell you even the colour of the belt and uniform assistant

> nurse, a registered nurse, nursing aids, is different. So, there's a militaristic, hierarchical approach. If you look at the doctor wearing a white coat and a stethoscope around the neck and, you know, has a title, senior consultant. These are signs of power and authority. Now, if we match our African culture with what is medical culture, we will find that it compounds in different ways. Look at the cultural things here in Uganda. There is still a fear of the leader. The hesitation to actually give constructive or negative or bad news to the senior, because of that fear of being passed, fear of being ostracised, fear of being demoted or punished in some way for telling the truth, as you see it. In the UK, I was taught to be assertive. And that assertiveness gave me permission to speak out in my very first Department of Medicine meeting, when I returned to Uganda. I was the most junior of the lot. I was the newest on the block. But I was able to speak because I had been given opportunities to speak in the UK. So, I think one of the things that I had to learn as a team leader when I was there is to give people the opportunity to engage the team leader, which sets the temperature or the culture. **2SMF—Senior Leader**

However, one participant—who had trained in both Uganda and the UK—disagreed that the hierarchical nature of leadership in the world of the natural sciences is primarily an African issue and observed that the West has only begun to emphasise collaborative leadership recently.

> Can I just say that I don't want you to go away thinking that in the UK they don't have the hierarchy of senior consultants and the rest of us being minions, because that was there. And funny enough, it's possible that that moulding came from the UK—the way that people are taught at Makerere University Medical School because they were British consultants coming over here and teaching people—the likes of those senior consultants. So, a lot of what we have here is inherited and it is still going on. And the struggle we're talking about now where we are trying to see how we listen, to listen to the youth, listen to the younger, listen to the more junior is happening concurrently in the UK as well as here. What I could see, though, in my training, is that the realisation that collaborative leadership is essential started much earlier in the UK where they actually started to incorporate it into our training. So, when I came back to Uganda, I possibly came with a different attitude because of my training in the UK. **2SMF—Senior Leader**

4.3.6.3 Leader identity and self-efficacy

Several participants interviewed observed that as scientists, they consider themselves to be amongst the brightest in society, something they said is accepted in society as well. The results show that this comes from the way students are selected to attend medical, engineering or agricultural programmes, where the top academic performers are enlisted. Additionally, medical professionals see themselves as smarter than the rest because “we study very complex things” (**4SMM—Senior Leader**). Furthermore, natural scientists carry the attitude that humanities and the study of soft skills is child’s play. Consequently, many do not prioritise the development of leadership skills because they believe that this is something they can easily pick up along the way or teach themselves from reading a book.

On the one hand, the results seem to show overconfidence accruing from leaders’ self-view as “a smart person who can easily learn simple things like leadership on their own” (**5SMF—Senior Leader)**. On the other hand, the results show that many scientists see themselves as individuals that do not need to invest in leadership development because they are “leaders by virtue of the qualification as a medical officer [or most technically competent scientist in a team]” (**6SMM-Senior Leader)**, thereby creating a cocktail of a disincentive to invest in leader development activities, even though they are full of confidence that they can learn leadership easily. The results appear to imply that the power of the natural scientists’ social identity could be diminishing the influence of the leader’s learner efficacy. This is specifically captured in the sentiments of the participants below.

> Actually, the attitude that we are superior is an attitude that has been there for a long time [laughter]. And especially when you look at Makerere, you know, the doctors, the medical school is away from the other faculties, so we end up isolated, and then I think it’s a fallacy in our minds as medical students. We refer to other students as penguins, and we feel that we are on top of the world. But the experience beyond medical school actually has really just proven us otherwise. **8SMM—Middle Manager**

> I think even just putting a little more time into those soft skills would help us get better in leadership. It’s assumed that the doctor will learn on the job, will somehow make intelligent guesses. He or she is supposed to be a clever chap anyway? You should get. But leadership, you don’t necessarily just get it. Sometimes you learn either from experience or even formal training is good. I personally think that even when you have a base, there needs to be more proactive training starting at the level of the young doctor who is still in training, to take up those leadership skills. **S5MF—Senior Leader**

4.3.6.4 Societal expectations

An emerging theme from the interview findings shows that there are societal expectations and conditioning that impede participation in leader development activities and reinforce the belief among scientists that they are superior. Several participants highlighted that right from high school, students who study STEM-related subjects are more highly regarded than those that opt for the humanities, by their teachers, parents and peers. Some participants also pointed to the power of the presidency in shaping the national psyche and suggested that the Ugandan president's consistent elevation of natural sciences as a superior path for developing Uganda, has enhanced the belief that natural science students are more valuable to society. According to several participants, this is exacerbated by better financing of science school programmes in government budgets and better remuneration of science teachers.

Additionally, this elevation of STEM subjects coupled with a subjective belief that science subjects are hard and complex, forces both the students, parents and teachers to put undue pressure on students not to engage in extracurricular activities and social clubs such as sports, drama, and student leadership—denying them the opportunity to start on their leader development journey through these developmental windows. In contrast, participants from the non-science group appear to show that such individuals got a heightened exposure to activities that nurture leadership skills right from their high school days.

> Coming to secondary school, I had more focus on academics and I just didn't vie for any leadership position at school. But in my A' Level, actually, the teacher responsible for prefects approached me and said, 'Why don't you go for a prefect position?' And I just said, 'No, sir.' At A' Level, there was this fear that people who go into such leadership positions, they take so much of their time that they may end up not performing well in academics, especially if you are studying sciences. There is that expectation of teachers and also parents, that sciences are difficult. **14SEF—Senior Leader**

The implication of this result could be that the attitude scientists have about the complexity of sciences and the irrelevancy of non-technical subjects such as soft skills makes them less inclined to want to learn them or to make time to learn them. This was echoed by several participants among the scientists' group, as highlighted by one key informant below.

> When you were a top mathematician in school, you stood out and if you were a top science student, you stood out. If your competency was on history, for example, telling the migrations of people and the socio economic reasons why they did A, B, C, D, E, it was not the important stuff. It's not what makes you stand out because it is considered not complicated things. So somehow the school pumps you up to despise that side of life, so to say. And as you go along,

> there is no point at which in the science career where someone can stop you in your tracks to correct that mindset and it just keeps growing. Even now, if I can borrow the example of the President, he is telling everyone how useless they are, unless they're scientists. We have propped up not to have a lot of respect for those things. And it affects individuals' desire to learn leadership skills, conflict management, politics, emotional intelligence and dealing with the messy stuff that where one plus one does not always equals two. So, you have to be very, very intentional to snap out of that space because there is an attraction to just ignore it and focus on your technical competence. And somehow believe that if I'm a good engineer, as long as I do my work, there rest doesn't matter a lot. **16SEM—Middle Manager**

4.3.6.5 Irreverence and irrelevance of soft skills

Another theme that emerged from the interview findings was that the natural scientist group has a social identity that builds on the superiority complex described in earlier sections. This attitude combines with the scientist mindset and ontological orientation, which advances the logical, positivist approach that looks down upon interpretivist approaches and creates a nexus between irreverence of soft skills and their irrelevance to career advancement. Moreover, the results appear to show that the technical demands of the industry require scientists to focus a great deal on building their technical competencies as opposed to leadership skills.

With the scientists' mindset, several participants observed that natural scientists are more oriented towards processes that align to logic, observable and measurable phenomenon with a positivist worldview. In contrast, non-scientist participants easily welcomed the interpretivist nature of human relations and behaviour, making them appreciate soft skills more as they are comfortable with the uncertainty in human relations, unlike scientists who might say, "as a scientist, you think black and white, and you find that a person is not necessarily black and white. They have emotions that have no straight formula" (16SEM—Middle Manager). This diversity in views and contrast between the scientists and non-scientists is captured in the participant voices below.

> We come from a place where knowledge and understanding is revered and everything is seen through the lens of evidence and bringing the scientific proof. Once you present the evidence, people then argue about it, but they accept it eventually when it is sound. Now, leadership in a political context has other considerations beyond what may appear as facts. You may have somebody who will not make decisions based on evidence, but will also bring in facts and consideration on how popular they would be, how it will affect their position, how much money they are likely to lose if they take the scientific routes. So, the humility to listen, and listening skills of finding out what is the other party's interest in this…without which I will not be able

> to convince them to change behaviour or to advocate for a particular point of view…not on the basis of facts, is something we as scientists does not come easily **2SMF—Senior Leader**

> At the end of the day, this leadership thing is about people. Human beings are hard to understand, they're hard to predict. Today, someone wakes up happy, at around 10am, they're different, completely different. And then we also have personal experiences, how we have been raised, where we come from, the personal circumstances we find ourselves in, our gender...So that diversity is one of the things that I personally consider and take as a core challenge in leading people…you cannot say that when you're meeting people, you've been given an understanding of everyone, and then you can predict them, that this one when you do this, they react like this. So, every day you just find yourself dealing with situations as they arise. **23NTM—Senior Leader**

The participants also highlighted that the nature of training for scientists and their demands to be excellent at the technical aspects of their discipline means that participating in leadership or activities to hone their soft skills will inevitably take a back seat.

> The state or nature of our training in science, mostly limits us from people—person interactions. I think if you can go back to our training from O' levels to A' levels, first of all, we probably were the smallest classes if you can remember. We probably were the male dominated kind of subjects, you know, so then you find yourself at University and we had only one lady in our class of 25. The structure and nature of our education already takes away from us the easily available skill of people - person interaction. For me to get good in leadership skills, it took projects like GIZ, to realise that, you know what, these applied scientists eventually have to deal with a social scientist, an accountant in the Ministry or within government or within politics or within the activity areas. So, we needed to train them. It was deliberate from our side. Otherwise, scientists were comfortable with just their technical areas. **15SEM—Senior Leader**

> With the humanities, one can concentrate in a short time and have it done, but the natural sciences, it's like you have to be consistent to develop a concept to see how it's applied, to get used to it and so forth. So, I think that's why the sciences are said to require time and effort to concentrate. So, when it comes to leadership, certainly there are certain times when student leaders have to miss out on some academic programmes, because of the leadership role and demands. So, science students end up missing on practicing leadership from early on. I saw the Arts students always copying notes from peers, but with the sciences, there are just certain things that you must pick in the practical lesson, in the that you must be there. They cannot

organise a new practical for you alone, and yet you must do a sequence of these practicals to get used to the concept. Natural sciences require consistency in getting this kind of incremental learning or getting grounded in a concept. **14SEF—Senior Leader**

4.3.6.6 Leader characteristics

This section looks at the characteristics that natural scientist leaders consider to have contributed to enhancing leadership skills and advancement in leadership careers. Some participants interviewed highlighted that being the firstborn in a large family contributed to their identity as a leader right from childhood. Others highlighted their individual ambition to be a high achiever, self-drive, internationality, self-belief, personal faith and desire to add value to people around them as drivers that have contributed to their growth in leadership and participation in activities that developed leadership skills in them. Specifically, several participants identified their faith in God as an aspect that pushed them to engage in religious activities at school and community, taking on leadership responsibilities even when it was counter-cultural for scientists to be involved in such activities—especially during the schooling years. Save for some scientists considering themselves as 'reluctant leaders' pushed into leadership, compared with the non-scientists, there were no notable differences in the personal characteristics identified as having been a contributing factor to participation in leader development and the resultant development of leadership skills. Individual personality was also noted as a contributing factor to participants having been driven to engage in leadership learning. Specifically, one participant spoke of their personality as one that gets bored easily with routine, with an impetus to start new things and develop other people to carry them forward. The following participant voices highlight the sentiment seen among the participants.

> I will call myself a reluctant leader, because I never really liked administration, leadership, I just wanted to be there and do my things, but at the same time, I appreciated that I can't do my things if where I am is disorganised and there was a lack of leadership. **1SMF-Senior Leader**

> I can say there's a lot of personal initiative, for example, one of our best leaders at URA, the current Commissioner—domestic taxes, is one of the Maxwell certified coaches. So, you'll find because of being a Maxwell certified coach, in most cases, whenever he interacts with staff, he will always bring in that coaching element. He wants to see that people are better. So, he will always want to talk to people, encourage people, give those motivational talks and those leadership quotes by John Maxwell. But you see, it is his personal initiative that he has decided to go for the John Maxwell leadership course, on his own, not as URA because of his desire to be a better leader. There are leader in URA who are not bothered of looking for such things. **24NTM—Middle Manager**

> I've always had that ambition for political office. So having done some consultation, I thought...actually in 2018 I sought to run for the office of Municipality Mayor. But then I had many challenges especially financial, so I decided to wait for 2021 to run for Councillor in the municipal. At least that will give me an introduction to the people. So that in 2026, I can easily move to a higher office. **8SMM—Middle Manager**

> I have combined both personal initiatives and a drive to experiment in growing my leadership skills. I read widely personally. Well, I've read several books about leadership, but also I have had an opportunity of being sponsored by the ministry and ministry allies to attend leadership skills development courses. I've had training in leadership. I have had the opportunity to sit with other leaders in the Ministry and we brainstorm, share, compare experiences, but also I've benefited from liberty to experiment, new ways of doing things… the ability to think whatever can solve this challenge and you arrive at the solution has been a good attribute. **17SAM—Senior Leader**

4.3.6.7 Organisational culture and practices

This section outlines the emerging approaches within the theme of organisational culture and practices and how they impact leader development. Organisational systems have an overarching, superintending effect on practices for behaviour, including leader development. As one participant put it, "Even scientists, as you work, there is a tendency where people think, 'uh, these are scientists' but when people go to learn from the other ministries and say, 'look, but Ministry of water is doing this very well. It's a science Ministry, what about you? What's wrong with MAAIF? Then you come back to the systems" (13SEM—Senior Leader).

The majority of participants among non-scientists identified *promotion into incompetence* as a ubiquitous practice. Several participants highlighted how in scientist-led organisations like MAAIF, one has first to prove technical excellence (For example, through years of practice, publishing research or amassing technical qualifications) before they stand a chance to be considered for leadership positions. According to the participants, whereas this is an accepted norm within natural science organisations, the practice of giving little attention to leadership skills as a pre-requisite for one to be promoted into a leadership role is worrying—precisely because such a role is mainly about leadership and administration than it is about technical hands-on operations.

Several scientists interviewed mentioned that during the application process for leadership positions, demonstrating leadership skills plays second fiddle to showcasing years of practice and technical qualifications—with some cases ignoring leadership qualifications and training as part of the minimum requirements. In contrast, participants within the non-scientist group highlighted that it is standard practice at their organisation for one to demonstrate leadership skills and leadership training before they are considered for any leadership position. In the non-science organisation, career growth is not constrained by years of service—as long as one demonstrates leadership and value to the organisation.

> Indeed, when an opportunity for taking up a leadership role comes up, among the critical requirements is experience in conducting technical duties and of course, it follows on the qualifications an individual has and most of the qualifications are technical based. Being in a science based institution, the best scientist has the higher advantage. But of course, there are interviews that are conducted for these leadership positions and not only technical questions are asked. There other questions to do with issues of integrity, there are issues of experience in taking up leadership roles. But most of the time the core considerations are number of years you have spent doing technical work. It should be noted that on very, very few occasions certificates in leadership are asked for as requirements in order to qualify or to be shortlisted in the first place. **17SAM—Senior Leader**

> At URA growing into a leadership position requires that you're trained; you have a leadership training as part of your qualifications. So that has pushed some people to go out of their way to enhance their leadership skills and not just wait for URA to provide training. Some of the people I believe have been pushed to read further on what leadership means, on leadership and management in general, because of our hiring and promotion policy emphasising leadership skills. And I also know that some of these people are already in supervisory positions, but they exhibit proactiveness, and strive to get better because they also see a path to move through the leadership positions. More so, the environment within which we work beyond URA now emphasises the importance of leadership more than ever as a key skill required for anyone who wants to put a mark on their profession or area of expertise. **22NTF—Frontline Leader**

> URA offers opportunities to anyone to grow into leadership positions. When a job is advertised, you can always come forward and lead the circle that you've been given. In URA, we have different bands of leadership and these many layers offer opportunities. I joined URA in 2013, I worked for about two years for me to become a supervisor and then team leader for a unit. One years later in 2016, I became a manager... Of course, one has to be technically competent in tax, but a lot of people focus on the technical side and forget soft skills because you really want to make sure that you influence people to do what is expected of them not to just follow you **23NTM—Senior Leader**

Furthermore, findings appear to show an emerging theme around the practice of conducting after-action reviews and embracing feedback, where the non-scientists organisation does not embrace these practices to the same degree as the scientists organisation. Participants tended to infer that in the few instances where after-action reviews are conducted, the natural science organisation focuses on the technical aspects of the project and not the leadership and management aspects. Moreover, the hierarchical nature of leadership and the way technical authority is used as a route through which contributions are made, was reported by some participants as making it very difficult for junior officers to give feedback to their seniors. That feedback is not integrated into the appraisal processes. The implication of this result appear to be that the organisational culture within the natural science organisation strongly attenuates the adoption of feedback and after-action reviews as approaches to leader development.

> Now, I had this guy who I'm supposed to supervise. The guy has been keeping quiet for years. I think he has been keeping to himself so many things, but eventually he talked to another person. His friend encouraged him to try to be open. We were doing some target setting and I told them that you see, 'I heard A,B,C,D. Why don't you come to me and we discuss things if we are to work together? We need to be as transparent as possible.' So, we had a discussion and I encouraged him to be open with me. He has now been coming to my desk almost every after three days and telling me stuff. So, I think as leaders, how carry ourselves and position ourselves to be approachable is really critical for feedback. This is not common in the Ministry. Even me, I am still struggling with it. When I've made up my mind, I don't want other contrary views, but when you sometimes start to talk, I learn to listen and realise that actually I have a team of young people who are brilliant. In most scientist led organisations we have that challenge of listening to our juniors. Some of us take ourselves as gods, and that is what is actually leading to low productivity in most of these organisations. That someone will give you just the bare minimum because they see that you are paying them to do your thing rather than involve them. Unfortunately, this might bring down some of the institutions. **19SAM—Frontline Leader**

Another emerging theme was that in the non-scientists group, employee turnover is high, and the organisation has a policy of recruiting from within to consolidate the desired culture, retain great talent, and motivate staff. As such, succession planning is strongly practised within URA as individuals with leadership potential are trained to take on senior roles and replace those who might have left. Moreover, URA limits the number of years that senior leaders can serve, whereas MAAIF was reported to only have leadership renewals after leaders reach retirement age.

> You see, now with URA, people keep leaving, so we want to do succession planning so that when someone, say a commissioner leaves the organisation, we have a replacement. So, we normally do training of leaders. We want to have a pool of leaders so that whenever a person leaves, there's a replacement. We don't want to get someone from outside to come and lead yet we have people who are capable inside here. It is also a motivation factor. **28NTF—Frontline Leader**

Furthermore, the qualitative interviews revealed another emerging theme concerning the learning transfer environment. In both organisations (scientists and non-scientists), it was reported by several interviewees that while attending training workshops, courses and programmes is commonplace, once people return to their posting after the training, they find that the environment is not conducive or welcoming of the new ideas and concepts that they would have loved to adopt. Some of the reasons advanced for the lack of support for the learning transfer period included: non-supportive line-managers who expect the returning leaders to continue business as usual, an entrenched leadership culture that is difficult to change without intentional effort from the top, and a lack of motivation among the returning leaders to apply what they have learned. Moreover, some interviewees highlighted the deafening power of a poor feedback culture in the organisation, in that, even when someone returns from training with great ideas, they will not be heard if they attempt to criticise the status quo or suggest new ways of doing things. This result seems to imply that leaders who elect to go for formal leadership training are unable to practice what they are learning once they are back to their organisation—thereby diminishing their ability to build those leadership skills. It might also discourage some from attending formal leadership training courses. The frustrations with a poor learning transfer environment are articulated in the participants' voices below.

> To the extent that the environment in which somebody is operating allows them to practice what they have learnt from a training without suffering negative consequences, training will be effective. If I'm to do formal leadership training and I learn all these principles, and then I come to an environment where the boss's word is final. Where everybody is cowed into fear of speaking their mind. To be able to make a difference, I'm likely to suffer negative consequences. And so, I believe that the training on its own is not sufficient. But if it is accompanied by an environment that can tolerate (even without being very open and very nice), but if it can just tolerate, you know, the implementation of new ideas from a training, then maybe you can have such training having a lasting effect. The last thing you want is for somebody to be so well equipped and then they come and try to implement some of these learnings and they backfire on them, they will say that 'these things don't work; let me just carry on.' And this has been common where people tell you 'You think you're the first one to learn leadership? We are giving you six months; you will calm down! **4SMM—Senior Leader**

In our organisation, we sometimes get leadership trainers, motivational speakers talking about what we're supposed to do. It is like these preachers who'll give you a sermon, you leave when the spirit is very high. Once they disappear, you go back to the default, and that is where, personally, I'm seeing ourselves struggling within the organisation. I wish we had a blend of the pure scientists and the guys who are core with leadership, in-house. So that we kind of cross-pollinate on a daily. But as long as you have pure scientists from the top to down, we are all looking in the same direction. It is until someone will come up after two years and remind about good leadership, then you get excited but after three weeks, you go back to your science. **19SAM—Frontline Leader**

4.4 Objective 2: Impactfulness of leader development approaches

Objective two sought to identify the leader development approaches considered more effective for natural scientists. Accordingly, the research question was—what leader development approaches are considered more effective than others within the context of natural scientist leadership and why? The results from the quantitative survey show the perceptions about the effectiveness or how much impactful respondents from either comparator group felt each of the leader development approaches to be. Table 4.9 below outlines the mean score of perceptions for 'impactfulness' among scientists and non-scientists. The highest possible mean score is five, while the lowest is one. Where there are statistically significant differences between the two comparator groups, this is highlighted in bold text. Whereas the scientists and non-scientists in the study were n=106 and n=115, respectively, only those who answered the question on impactfulness are included in the table below n=93 and n=96, respectively.

Table 4.9 Effectiveness/ impactfulness of leader development approaches

	Mean score (1-5)			
	Scientist (n=93)	Non-scientist (n=96)	F	Sig.
COACHING	4.02	4.30	3.945	**0.049**
MENTORSHIP	4.37	4.45	0.574	0.450
FEEDBACK	4.26	4.45	3.139	0.078
EXPERIENTIAL LEARNING	4.29	4.43	1.988	0.160
E-LEARNING	3.61	3.85	3.638	0.058
FORMAL LEADERSHIP TRAINING	3.89	4.22	7.414	**0.007**
NETWORKING	3.98	4.32	9.361	**0.003**
LEADERSHIP ROLES	4.10	4.43	10.352	**0.002**
SELF-DIRECTED	3.89	4.26	9.498	**0.002**
SELF-AWARENESS	4.08	4.45	9.922	**0.002**

Scale 1 (Not at all impactful) -5 (Extremely impactful)

The results in Table 4.9 appear to show that for scientists, the leader development approaches that are considered more effective and impactful in nurturing leadership skills are mentorship (mean= 4.37), experiential learning (mean=4.29), feedback (mean=4.26), acting in a leadership role (mean=4.10), self-awareness (mean=4.08) and coaching (mean=4.02). These had a mean above 4.0—the maximum possible mean being 5.0. In contrast, for non-scientists, all approaches appeared to be relevant and impactful except e-learning that scored below 4.0. This, and the fact that non-scientists rated six of the ten approaches significantly higher than scientists ($p<0.05$), collaborates the sentiments in the qualitative interviews that non-scientists relatively had higher exposure to these interventions than scientists. The least effective among the ten approaches studied appeared to be e-learning, self-directed learning and formal leadership training. However, despite being the lowest ranking in the list, these approaches scored above average, with mean scores of 3.61, 3.89 and 3.89, respectively.

In all the leader development approaches, the non-scientists perceived the impactfulness of each approach to be higher than the scientists. However, the difference in perception of impactfulness was only significantly higher in six approaches at $p<0.05$. These included coaching, formal leadership training, networking, acting in leadership roles, self-directed learning and self-awareness. The implication of these results might be that non-scientists see more value in undertaking these activities than scientists do. The qualitative interviews shed more light on the differences in perceptions between scientists and non-scientists, of the effectiveness of various approaches in nurturing leadership skills and consequently leadership effectiveness. These findings are presented below.

4.4.1 Coaching

Even though most leaders interviewed in both groups said it is one of the approaches they had least engaged in, coaching was relatively well understood among non-scientists compared to scientists. This could explain why it was considered significantly more effective by non-scientists compared to scientists. Many scientists misconstrued coaching as mentorship. One reason advanced as to why coaching is an effective approach in developing leaders (it was rated high by both scientists and non-scientists, see Table 4.9) was that if somebody is trained as a professional coach, they are more likely to imbue the discipline of coaching, which then empowers the leader being coached to grow in awareness. The increased awareness and clarity over their leadership performance opportunities and challenges enables them to develop a solution by themselves—as a solution that is more likely to have context fit and therefore be implemented. As such, coaching was seen by several participants as practical compared to approaches that increase knowledge and understanding but may not push the leader under development into deliberate action. Coaching was also reported in one qualitative interview as an approach that provides psychological safety and security, where a senior leader can open up about inadequacies without fear of embarrassment, as would be the case in group-based learning environments. However, the approach was considered not well practised because there are very few professional coaches in Uganda with the industry in its nascent stages. Moreover, line managers who could also practice coaching as a leadership style were reported not to have been trained.

> Coaching is a practical quick fix for leaders in senior levels who are natural scientists and very naive about soft skills. It is the quickest way for them to improve; first, because it is highly personalised and practical. Most of these senior leaders do not want to attend leadership training, and they keep recommending training to lower cadres because attending leadership courses and you find yourself with some junior officers in the same class can be embarrassing to some of them. But with coaching, it gives them the security and privacy to be vulnerable and also get practical help. **3SMM—Senior Leader**

> I have done coaching with the John Maxwell Team. Coaching brings a new awareness on the way you influence teams, how you feel, the way you carry yourself and how you impact others. Even simple things like the tonality of voice, body posture, body language, and other things that people pick up on. I would never have thought when I was doing engineering equations that these things actually matter for me to be able to deliver an engineering product. But yet you find that they are as equally as important as the technical things that you're dealing with. So, for me, I've been lucky to get coaching, because I don't think as many people have had the opportunities. **16SEM—Middle Manager**

The results seem to imply that coaching is well aligned to the needs of senior leaders, and being that it is an expensive activity, it could be prioritised for such leaders. Coaching and its effectiveness could also be improved by training leaders as coaches to provide this support to their direct reports.

4.4.2 Mentorship

Mentoring was a popular approach across all interviews with scientists and non-scientists stressing their experience with the approach. It was an approach that was largely misconstrued as interchangeable with coaching, and some participants spoke about mentoring and coaching when describing a specific experience. Even though the quantitative survey does not show a significant difference between scientists and non-scientists in their perception of the effectiveness of mentorship, qualitative interviews appear to show that the approach is perceived to be highly effective for scientists. This was attributed to the practical nature of natural sciences and the need for handholding for one to understand both the technical and leadership aspects of senior roles. Mentorship was also seen as effective because it reduces the learning curve since there is someone the leader can reach out to and get quick support on any leadership decision or challenge.

Moreover, having role models was reported to be a common feature of the way natural scientists learn and grow in their industry. Mentorship, however, was considered to be time-intensive and that to be more effective, efforts have to be made to nurture good relations between the mentor and mentee. Additionally, some participants highlighted that mentorship effectiveness could be improved if it was integrated with feedback and coaching and if organisations promoted it and encouraged it—albeit without making it too structured that the relationship between the mentor and mentee is unnatural.

> Mentoring and coaching, as opposed to training allows you the opportunities to always seek out guidance from the mentor which helps you maximise the effort to learn and understand concepts from a practical or from an experiential point of view. With mentorship, you're picking from the experience of someone who has been there done that. For example, a mentor will share a practical experience that you can pick from. If I needed to find a solution to a leadership challenge I am facing, a mentor is someone I can bounce back my ideas with and get a quick solution at that moment. So, it's more practical, it's more relatable, and depending on the relationship you have with your mentor, your coach, I think there's a lot of learning that happens if the relationship is booming and where your mentor gives you time. **22NTF—Frontline Leader**

> My experience has been that a mentor can be a person who has your back, especially if both of you are in the same institution. It can be somebody who can have your back, somebody who can potentially even take a bit of the responsibility on your behalf if things go wrong. But definitely somebody who can help you see things that you may not have seen and particularly somebody who can give you feedback and you're sure that this person wishes you well and has your best interest at heart. A lot of the times people do not know whether those who are giving them feedback, those who are pointing them in a certain direction, those who are asking them to examine certain aspects, actually wish them well. Which makes it difficult to accept the feedback but with a mentor, it makes feedback more appreciated and adopted. **4SMM—Senior Leader**

However, mentorship was reported to be challenging among scientists despite its ubiquitous application and strong appeal. According to several participants, whereas mentorship was working well on technical skills, it was not as effective on the soft-skills side. This was because who mentors someone matters. Several participants mentioned that many senior scientists have not been very good at leadership, and they learned the same defective ways of leading from their seniors who may not have known better—something that creates a cycle of learning a traditional non-effective way of leadership.

> Now, the people who trained doctors are usually doctors themselves. So maybe that's already where the gap is going to come in. So, who is going to train who, where are they going to get the leadership skills, if themselves they don't have that skillset? So, there's an inherent weakness in the system that doctors are taught by fellow doctors. I don't know how many times those senior doctors abused us…someone who tells you how he's very clever and he's the best thing that has ever happened since whatever. So, we already have that weakness in that the people who are training and mentoring may not necessarily be the best trained. They may not have the skill that we are talking about. Not everybody knows how to impart knowledge. Not everybody even knows or has knowledge of really what's a good leader. **S5MF—Senior Leader**

4.4.3 Feedback

The results from the quantitative survey show that although both scientists and non-scientists scored feedback highly as an approach that is effective in nurturing leadership skills, the difference was not statistically significant. This is collaborated by the qualitative interviewees whereby participants from both groups recognised the value and impactfulness of feedback. However, the use of 360-degree feedback was more pronounced among non-scientists—albeit not such a widespread practice there either. Some participants suggested that the overall culture in Uganda is one where despite a general understanding of the value of feedback, very few organisations and individuals have adopted the practice. Among the non-scientists, one participant observed that the use of 360-degree feedback has been sporadic in the organisation but that recently, URA has trained its leaders and institutionalised 360-degree feedback as part of evaluating transformation in leadership skills after the training period. According to this participant, 360-degree feedback is given greater effectiveness once it is integrated with the pre and post formal leadership training evaluation, presumably because trainees and their direct reports would be expected to observe and report any behavioural transformation after the training.

> The issue of feedback, I think we need to appreciate our cultural context. In our Ugandan culture, people usually don't tell you the truth in your face. So, on the issue of feedback, I think it has not been a strong contributor in my learning of leadership. I tried it myself when I was a supervisor and I realised that I work with people who take issue with you telling them what they've not done right. Rather, you write it down and don't tell them to their face. Myself, nobody has sat me down and told me, 'this one you've not done it right.' Usually, you just figure it out yourself. And somebody might be rating you wrongly, but they don't tell you why they're rating you low and where you need to improve or even have a chance to discuss. I realised it was a cultural issue, because people don't want to tell someone openly what is not good. **23NTM—Senior Leader**

> The 360-degree assessments are catching up a bit and leaders continuously provide each other feedback in areas of improvement. I would not say that we have a process that has really worked well for us because all of the feedback interventions are in the testing phase. We are starting out, so, I can't say that this has really worked for us. However, what that training has done is to create an awareness for our leaders to provide feedback to each other but also helped to raise expectations from the people that they lead. So, people who they are leading know that you've been trained as a leader, and that people around you will hold you accountable whenever the opportunity comes up. **22NTF—Frontline Leader**

Furthermore, other aspects reported as critical in making feedback effective include training people on giving and receiving feedback so that they do not misuse or abuse the process—say by attempting to tarnish someone's name. Additionally, the approach is improved by leaders having to create an open, inviting demeanour that welcomes feedback, thereby increasing people's self-awareness and acceptance that they do have blind spots which colleagues can help illuminate. Several participants highlighted that giving constructive feedback in a face-to-face environment is counter-cultural, and leaders must make efforts to create a safe environment to be given feedback. The interview results also show that feedback can be even more effective when given regularly and integrated into existing mentoring or coaching relationships and not reserved for the formal appraisal meeting as many leaders were reported to be currently practising. The fear of giving candid feedback was attributed to the wider country culture and the organisational culture—where senior leaders do not create a psychologically safe environment to receive feedback, perpetuating the fear of retribution.

> Feedback is a practice that we have picked up, and for those that have gone through it, have actually appreciated that sometimes we are blind and ok, it's not even sometimes. The Johari window says that there's always that part of you that you don't know about yourself and other people know about you…that is where the feedback comes in. And some people, depending on who is giving feedback will be in denial and others will accept it. And if you accept feedback, you'll always see that probably from your personal view, everything seems ok, but your actions have an impact on the people around you. **22NTF—Frontline Leader**

> The fact that there is a fear of unemployment outside there, someone cannot talk openly to the boss because we know that our bosses are emotional and they can turn the criticism [against you] yet, it was the kind of criticism which is for feedback purposes to the leader so that he can improve, but they may take it personal. So, you'll find in most engagements and most forums, once your boss has talked, you might not criticise. And even if you called him one on one, and you said boss, you

are wrong here, so you'll find we're like in a military environment and where they say *'order ni moja'*—once they give you orders, you don't edit. **25NTM—Frontline Leader**

The culture should be one that is willing to give feedback and willing to accept feedback. Now my experience with Uganda is that most people go through school and they are told not to be critical or not to provide critical feedback to their leaders. So, both the led and the leader are very unwelcoming of feedback, so whereas it would be good, it is seldom practiced as an aspect of improving leadership. Just because of the power dynamics and training in general. You know, you don't tell your dad that what they're doing or the way they're running things is not right. **3SMM—Senior Leader**

4.4.4 Experiential learning

Experiential learning is a theme that cuts across most interviews as the main approach through which leadership skills are learned within the natural scientist group. It is also an approach that aligns well with how the natural scientists are trained in technical skills, relying heavily on the apprentice model and development through practice. As one participant, a medical doctor put it, "When it comes to scientists, really we learn by doing … I think it could be a function of our training where we are not trained to be leaders in administration" (9SMM—Senior Leader). Most participants described their leader development journey as one where they were thrown in the deep end of leadership and were expected to learn on the job, through experience and reflection on the good and bad decisions and by muddling through their leadership challenges. The practice of reflection on one's experience and mistakes as they learn on their own while also integrating it with self-directed learning, such as reading leadership books, was highlighted by scientists as one that increases the effectiveness of experiential learning as an approach for leader development. Some participants suggested that internship and industrial training (key aspects of experiential learning) enables scientists to interact with other professionals and see first-hand the value of soft skills in interdisciplinary teams. This makes experiential learning effective, particularly if the scientists are provided with a leadership role in a multi-disciplinary project.

For me, being in a project is a good way to share experiences, get to know the challenges in leadership and how to handle them, you get to know even the different ways organisations handle issues. For instance, in that project that we are in with the leadership of UCT…through my interactions with leaders from eight universities we get to understand how Gulu does things, how Kyambogo does things, how Makerere does things etc. And we kind of get a blend in learning the best practices. **14SEF—Senior Leader**

However, experiential learning and the use of projects to develop leadership skills were reported to be ineffective when other contextual influences such as organisational culture and authoritarian leadership styles come into play. One participant suggested that if projects are to be used for leader development purposes, it is important that the top leaders in the organisation first buy into the purpose of the project as a developmental opportunity for the leaders involved and sign-off on the metrics that are to be used in evaluating both the success of the project and the learning of leadership. The implication of the result might be that without this process, it is likely that the leader development objectives of the project will be ignored, and no opportunities for reflection will be deliberately scheduled.

> Putting the scientists together with non-scientists or social scientists, for purposes of scientists learning through the emerging relationships, networks and reflection is an effective approach in developing leadership. However, when you are dealing with technocrats in government entities, you are likely to still have the ultimate decision maker—the leader—bailing out of the team, and not benefitting from those experiences and reflections. So, you have a team working, but all the effort of the team is just thwarted by one person who comes to say 'This is bullshit,' because they have not been part of the team processes. If you want to develop that leader who is at the senior level, the most effective way to make sure that they are part of the action and they reflect on the action and learn, would probably be to have a set of expectations or deliverables that are not related to the technical outcomes but you assign this person deliverables such as levels of engagement of the team. Measuring team creativity, team cohesion and such non-science parameters related to the process and then making such a leader the person responsible and accountable for delivering on those, will make those senior leaders benefit from projects as leadership development platforms. **3SMM—Senior Leader**

Additionally, it was highlighted by two participants among scientists that in their organisation, opportunities to take on a leadership role within a project—as a way of nurturing one's leadership—are limited. While the projects exist, organisational politics and excessive lobbying mean that a select group of leaders are usually recycled to head projects. The implication of this result could be that despite its strong appeal and effectiveness, for organisations riddled with politics, only a few leaders get nurtured through this leader development approach.

> Learning leadership through involvement in projects is a very good opportunity, but the opportunities there are very limited. At the senior level, as you can imagine, there can always be one leader in any community or in a group of scientists. So, yes, it is a good aspect, but it gives very few people a chance to take on the wheel, to take on the responsibility. The arrangement is that you can't be changing a Coordinator weekly or monthly. People learn from those experiences, but it serves and impacts only a few people. It will develop very few leaders

out of the pack at the end of the day. If you're trying to help people become leaders, you'll get a few good leaders, but not many would benefit from this arrangement. **17SAM—Senior Leader**

4.4.5 E-Learning

The results seem to show that e-learning is not a well-respected mode of learning leadership and that it has been recently adopted due to COVID-19 restrictions on travel and meetings. Several participants in both the scientist and non-scientists groups highlighted that the disruptions involved in virtual instructor-led training are many, the levels of engagement from participants are low, and that problems with internet speeds in Uganda make it challenging to learn difficult concepts. Moreover, some participants suggested that many trainers they have observed are not savvy in delivering meaningful interactions during virtual training sessions. Moreover, as one participant who is a specialist in learning and development suggested, in government agencies, beyond the value of knowledge, there is a motivation to attend physical conferences and training workshops because of the financial benefits that come with travel.

> For e-learning, some people are interested, others are not. So, it's like a culture that we are building now because in the past, people have looked at training as a travel abroad opportunity. So now asking them to turn to online training is completely a turn around and, you know, the travel had other motivators, other benefits like per diem, but with online learning, you push yourself, you're required to push yourself to complete the course. So again, there's a lot of change management that we have to do, although the COVID-19 crisis has actually forced people to now focus more on online learning. **22NTF—Frontline Leader**

> Online learning is a very new phenomenon. I have watched and observed an upsurge of consumption of material. Many leaders are reading up on leadership, reading up on problem-solving, they are more willing to take up information. It is an opportunity because we are also dealing with a country which has very poor infrastructure. So, if you are to meet with me three times every week, for a workshop, that would be a very huge task to accomplish because of traffic issues. But now with people beginning to appreciate things like Zoom, things like podcasts and just general online engagement, you are able to be in more than one place at a time and you are able to get to a place without having to endure two hours of traffic. **6SMM—Senior Leader**

The implications of the finding might be that despite the growing arsenal of tools for interactive e-learning, the perception that it is not as effective remains a considerable obstacle for many scientists to adopt the approach.

4.4.6 Formal leadership training

The results appear to show that formal leadership training is a popular approach for leader development for both scientists and non-scientist groups. However, the non-scientists significantly perceive it to be more effective than scientists do ($p<0.05$, see Table 4.9 on page 159). The qualitative interviews show that formal leadership training is considered effective, partly because most leaders have been substantially exposed to it and value the skills the process has imparted in them. Several participants among scientists suggested that with formal leadership training, they get guidance from experts and gurus in the field, expertise that mentors in the scientific field do not usually possess. Moreover, participants mentioned that formal leadership training is promoted within many organisations. However, two non-scientist participants explained that as a matter of policy, promotion to senior roles underscores formal leadership training as a minimum requirement, which also adds to the affinity towards this leader development approach. In contrast, scientists are not required to have formal leadership training qualifications as a minimum requirement—something that three scientists interviewed and one FGD participant in the scientist group mentioned would be a welcome policy and an incentive for natural scientists to take formal leadership training more seriously.

> Of course, there are people who have failed to change despite the trainings, but we have seen some results from training, especially for supervisors. We've seen changes. People become servant leaders. We've seen increased team work, there's improvement in communication. Well, if we continue like that, I think we will have better leaders in the future…there is definitely some change…and we have a policy of not recruiting from outside, and some positions require that you present a certificate or qualification that shows you have undergone leadership training before you are shortlisted. **28NTF—Frontline Leader**

> I think it brings a lot of value to have time away and have someone with the expertise to impart the knowledge that you need. And then you can go and try to implement these things in the environment where you do your technical work. And matter of fact, training would even be better if it is not just a one-off classroom teaching, but a follow-up kind of coaching programme where you come back and share notes and experiences so that you can be validated or corrected on how you are implementing the knowledge that you're learning in the leadership training programme…there are no people to train you on the job because many of them in the technical services need help a lot. **16SEM—Middle Manager**

Qualitative interview results appear to show that the effectiveness of formal leadership training is enhanced by selecting the right people for training—individuals with leaderlike characteristics and potential for leadership. It is also enhanced by a heightened relevance of content to one's leadership challenges, which, as some participants suggested, is achieved by clearly linking the training content to the organisational goals, competence framework and core skills required to perform in the role. Furthermore, formal leadership training was considered effective because learning and development practitioners can align and tailor training content to needs.

> Formal trainings try to address challenges for each level because the challenges you face when you're leading at the top may not be the same when you're leading teams of five, four people. So, the formal training tries to address that… for now, formal training is what stands out for us as a method of developing leaders because it has really heightened the awareness and the importance of leadership at all levels. **22NTF—Frontline Leader**

Specifically, several participants singled out a phenomenon that makes formal training less effective in public service organisations. It was highlighted that the financial incentive accruing from travel per diem and training/out of station allowances has unintended consequences where some individuals sign up for training programmes that are not aligned to their growth needs while other senior officers perpetually elect to undertake multiple training opportunities at the expense of others. The implication of this finding could be that in a context where the deserving leader for a specific training is not selected, formal leadership training as an approach becomes ineffective in nurturing leadership skills among those that need it.

> People are putting in a lot to learn leadership skills, but I think the biggest problem has been the public service culture. Many people have been learning and acquiring skills that they don't need but because there's an opportunity to go and train, especially if it is abroad. You find that the training programmes were not driven by the staff's appraisal. The appraisal process is not used to discuss between supervisor and appraisee where one would establish that they need this training. But when an opportunity comes in financial management yet this one said he needed the training in communication he goes for the other one of financial because that is what is available. So, you find that people have studied a lot, someone has even done an MBA, this one has done something else. Yes, people want to learn even beyond their areas of need, but it's being influenced by what is available. **13SEM—Senior Leader**

> Many times, the same faces show up in the training workshop, and they are always in some training workshop or flying out to undertake a course. People are driven by per diem. So, the

> training would be effective if the right people were attending them but if the training has no allowances, it is delegated to the juniors. For the attractive training opportunities, the bosses attend. **FGD Scientists—Female**

Furthermore, some interviewees suggested that formal leadership training is not effective as a stand-alone approach and needs to be integrated with mentorship and coaching to aid the learning transfer once the leader returns to the workplace. Participants who felt that formal leadership training is not effective mainly had concerns with learning transfer where individuals are trained but are unable to practice the skills taught for one reason or another. Specifically, some participants pointed out that the nature of leadership skills being soft skills that require practise and the hardwiring of behaviour changes and attitudes, approaches outside of class that involve reflection, action learning, and one-on-one handholding might be more effective. However, as one participant highlights below, in many cases, the purpose of formal leadership training is not to have it as an end in itself but a starting point to enhance awareness and provide guidance on which other methods can build.

> Some of the aspects in leadership cannot be trained in a class setting and when experts are training, actually, they're not training you to be a good leader there and then. They're just giving you the basics of which you'll start on to be a good leader. They might not change you at all. I cannot take you to class, train you and we leave class when you are changed as a good leader, no. I'm just giving you the basics, of which you'll go and be able to add on from there, because when you go to leadership, there are different leadership styles you need to apply in different situations. **25NTM—Frontline Leader**

> I think mentorship puts training into perspective because with mentorship, it allows you to apply the training. Training is important. I can't say training is less important, but we have also got trained leaders that their credentials only stop at the fact that they [were] trained. But they can't apply what they have, you know? They have the certificate, but they don't do the behaviours. **14SEF—Senior Leader**

4.4.7 Networking

Results appear to show that non-scientists significantly perceived networking to be more effective than scientists. Participants among non-scientists reported that networking is a common feature in their development as they travel to other tax jurisdictions to benchmark on best practices, build relationships across tax bodies in the region, and collaborate more with counterparts in the East Africa common market. Whereas many of these benchmarking activities are often primarily on technical tax engagements, the exposure to other cultures and leadership styles was highlighted as an aspect that makes such an approach effective.

> Benchmarking has mainly been in terms of growing the organisation and the tax, the tax elements. I had a friend who was sent to England to work with the revenue authority of England for one year. There is another manager who also went there for about one year, in the area of tax investigations. If there is a need to learn how to improve say on the e-tax system, then leader go and benchmark from India, China, etc. It's purely for the development of the tax administration, not for leadership, but people come back with improved leadership skills overall. **24NTM—Middle Manager**

The results seem to show that the approach of networking is not popular among scientists. Some participants suggested that the nature of work for natural scientists draws heavily on their introvert energies as they get focused on technical work, for example, in the lab or small specialised groups. They attend conferences to publish their research and meet the required continuous professional development (CPD) hours, but that this approach is not something that they use to hone their soft skills. Moreover, the results seem to show that scientists belittle politics and the use of personal charisma, connection and relationship to advance one's interests instead of relying on the strength of one's scientific achievements. This attitude was spoken about by several scientists interviewed with the scientists FGD also corroborating the perception. One participant voice below summarises the perception on networking as a leader development approach among natural scientists.

> First of all, I think the mentality of scientists is that science is very complex and hard… you are doing complex things, you don't have time to do these things of networking […] I used to see humanities students, like the people doing marketing and by 3pm, they are busy socialising in the halls of residence. And for us, it's like we are just starting. You have to set up experiments and all these other things. So, you become you and yourself and your experiments and you don't interact with other people because for them they have a lot of time to interact because maybe it is part of their curriculum that you need to give these guys time to connect with people and understand how to influence others. But on this other side, I think they just want to see that you are always busy throughout. Now, even at work, it is the same thing. People sometimes leave office at midnight. When do we get time to really connect with others and understand what others are doing? Actually, at one point we felt like if we are invited for a workshop or a meeting, it is a waste of time. I have better things to do, I have this report to deliver […] but what I'm also realising is that networking is critical. **20SEM—Middle Manager**

The implication of this result could be that the social identity among scientists—as an exclusive group of sophisticated individuals who must spend their time building on the technical skills and delivering on a superior technical outcome—as the path to career growth and the way to stardom, attenuates the impetus for engaging in networking as a valuable leader development activity.

4.4.8 Self-directed learning

The quantitative survey shows that non-scientists rated self-directed learning significantly more highly than scientists as an effective approach to leader development ($p<0.05$). That notwithstanding, many leaders interviewed in the qualitative phase identified self-directed learning as a regular feature of their leader development—particularly among scientists. For scientists, learning leadership on one's own and muddling through experiences was reported to be the fundamental way people first learn leadership. Nonetheless, there were participants among scientists, specifically two, that said that even finding time for self-directed learning on leadership is difficult. Activities undertaken in the self-directed learning approach included reading books, biographies, subscribing to podcasts, audiobooks, video-based programmes, following leadership gurus' blogs, social media, webinars and enrolling for self-paced online leadership development programmes. Given the lack of interactivity whereby one cannot ask questions or get specific guidance from an expert, this method was not considered very effective. However, it was said to be very accessible. The pattern emerging from qualitative interviews seems to suggest that to improve the effectiveness of self-directed learning it should be integrated with group discussions, book clubs, and mastermind peer-peer conversations about themed topics. This finding seems to imply that the accessible nature of self-directed learning makes it pragmatically impactful, even though it is not considered very effective.

> Specifically on leadership, I think there has not been much in terms of self-drive except for a few books and articles you come across. Something like two pages run through to refresh your mind. Most of my growth has happened more as a result of a crisis. In a crisis, that is when you reflect and say maybe we would have done A, B, C, D. Or how did we get here? **19SAM—Frontline Leader**

> Basically, what has contributed to my leadership growth is learning on my own. Because the moment I came out of school and then my first job, I was managing people…and people wanted me to learn how to manage. Reading about management, asking myself, 'what is management? How do you manage people?' And I think I was very deliberate because I realised that it was a skill that I didn't have. And yet I was managing people. So, I started learning my own, reading books, articles, listening to the likes of John Maxwell, Ken Blanchard, Covey. But later I went back to school to study public health and understand management. **7SMF—Senior Leader**

4.4.9 Self-awareness

The qualitative interviews appear to show that while many leaders appreciate the value of self-awareness, it is one of the least practised approaches to leader development. Several scientists interviewed mentioned that appreciation of the diversity of opinions and perspectives is rare and challenging for a group where people have strong egos and technical hubris. Some participants noted that self-awareness is enhanced when combined with a culture that welcomes feedback and where diversity is appreciated so that leaders can harness the giftings and personalities across the team without seeking out only the kind that they prefer.

> Self-awareness and emotional intelligence training has been fundamental in my growth. The core paradigm shift came from the appreciation that being different is not wrong. We were trained, even as children, that being different is wrong. When you're of a different tribe, that is wrong, and if you think differently about something, that is wrong. So, self-awareness training emphasised that being different is not wrong. You are simply different. You have a different idea or a different personality, it's not wrong. It's just different…you don't have to be enemies because you have a different viewpoint about something. To be honest, when I think about a number of my colleagues, very few of them have taken that journey of self-awareness to appreciate one's approach to life and how different it is from others. It's not promoted much. It's actually in the non-core medical organisations where people care to build leaders, where it is done. I worked in the civil service for long, there was nothing like that. There it is basically leading by chance, just hoping that things will work out. **4SMM—Senior Leader**

> We have a boss culture. And the boss culture is that the boss is the boss because they are very good at what they do and they are boss because they are on top of you. So, they cannot possibly be having some challenges with themselves or with their personalities that could affect their ability to lead better. So, you find bosses driving out people who are not exactly their type, driving them through the wire or beating them into subjugation. Because of the scarcity of employment staff stay but not delivering their best for the team. So, self-awareness is very essential, I would actually put it way high above feedback. **3SMM—Senior Leader**

The results seem to imply that scientists need deliberate efforts in promoting the value of diversity and appreciation of the impact of personality preferences on interpersonal relationships. Without such calculated promotion, this leader development approach will not be well utilised despite its value.

4.4.10 Leadership roles

Giving someone the responsibility to act in a role was highlighted as a common approach to leader development. The results appear to show that both scientists and non-scientists elect to use this approach, especially for succession planning purposes—building a pipeline of leaders and for business continuity purposes. It is considered effective, primarily because it gives the apprentice an opportunity to make decisions at the next level where they could be promoted to, builds the leader's confidence and exposes such a person to challenges, risks and relationship hitherto not experienced. However, some participants retorted that its effectiveness is dependent on how intentional and deliberate the practice of acting in a role is used within the institution. In some cases, individuals act in a role out of necessity—say when the substantive leader is out of the station—but without deliberate efforts from the institution to use that period of acting in a role as a developmental window. Participants seemed to suggest that the effectiveness of giving leaders the opportunity to act in a leadership role as an approach to leader development can be enhanced by planning in advance which roles are inclined to develop specific skills, which activities, challenges and relationship would be required to imbue such skills, and then lining up leaders that need to nurture those skills in anticipation of an opportunity opening up.

> I wouldn't say we're intentional about acting in a role because if I'm a manager and there's a supervisor below me, obviously, if I'm not around, that person will act, but the intention is not to help them prepare and grow. The intention is to make sure that there's someone who can fill that position if the substantive is unavailable. Even when it comes to promotions, it does not mean that because you have been acting, you'll be considered for that position and yet the thinking will be that if you have been acting, taking the decisions required, the learning curve will be much easier. There are instances where we've had people acting for long, but then the interview results come back and they are not appointed. That means that acting in a role was not deliberately used for the intention of preparing you, yet it should be. Ideally, it should be. But now, we want to more intentional because we are big on developing leaders. **22NTF—Frontline Leader**

> Our bosses can leave you to act, delegate to you without even giving you an insight, or a summary. Challenges come and you learn the hard way. You're forced to take painful decisions. As a leader, there are moments when you have to take difficult decisions and because they've left you with the responsibility, you have no option. Previously, you would all the time say 'let me call my boss', but now you're the boss. All the time, 'let me call so and so', but now you're the escalation point, everyone escalates to you, so, whether you want it or not, you have to exercise your leadership. **25NTM—Frontline Leader**

The results from the qualitative interviews seem to show that although both organisations struggle with deliberately structured processes for leveraging the acting in leadership roles to nurture leadership skills, the non-scientist organisation appears to be ahead of the learning curve. Several participants from the non-scientist group reported having grown in leadership as a result of this approach. For example, as part of its strategy to extend services closer to the customers, participants noted that URA has opened three satellite branches. On the one hand, these branches do not yet contribute a substantial revenue share to the organisation's overall target (and therefore, mistakes are not costly). On the other hand, their novel nature means that such stations are rife with leadership challenges. As such, these branches are used as a breeding ground for high potential leaders. Participants noted that promising leaders at the lowest rank of 'Officer' are sent to these stations as team leaders to develop their leadership skills in preparation for promotion into the next rank of supervisors.

This results seem to imply that the effectiveness of acting in leadership roles depends largely on the intentionality of the people and culture team and how they integrate organisational processes such as succession planning with leader development. The approach cannot be left to an ad-hoc haphazard process.

4.5 Objective 3: Leader development approaches and leadership effectiveness

This section seeks to identify how levels of leadership effectiveness relate to the extent of exposure to leader development approaches. By so doing, the section identifies the leader development approaches that are more likely to engender leadership effectiveness in the context of natural scientists. The section starts by outlining the levels of leadership effectiveness between scientists and non-scientists for each dimension of leadership effectiveness.

4.5.1 Leadership effectiveness

Leadership effectiveness was computed as an overall index that combines all the computed dimensions of leadership effectiveness as described in chapter three (sections 3.12). Additionally, means for the various dimensions of leadership effectiveness were compared between scientists and non-scientists using the analysis of variance (ANOVA) and F-tests. The results are outlined in the tables below.

Table 4.10 Leadership effectiveness

	Mean score by profession			
	Scientist (n=93)	Non-scientist (n=96)	F	Sig.
Role Ownership	4.36	4.42	1.011	0.316
Emotional Intelligence	4.38	4.45	1.342	0.248
Servant Leadership	4.29	4.38	1.813	0.180
Strategic Thinking	4.24	4.32	1.217	0.271
Ethics and Accountability	4.52	4.65	4.194	**0.042**
Performance Management	4.35	4.48	3.224	0.074
Decision making and Problem Solving	4.32	4.38	0.702	0.403
Team Leadership	4.53	4.63	2.098	0.149
Communication Skills	4.22	4.31	1.911	0.169
Innovation and Creativity	4.24	4.25	0.012	0.914

a: Scale 1 (Never—Never demonstrates competence) -5 (Always—Continually demonstrates competence)

The results in Table 4.10 appear to indicate that, save for the dimension of ethics and accountability, there were no significant differences in perceived leadership effectiveness between scientists and non-scientists. Whereas non-scientists scored higher than scientists in their perceptions that they demonstrate expected leadership behaviours, this difference was not statistically significant—save for the dimension of ethics and accountability. In all the other dimensions of leadership under study, scientists perceived themselves to be as effective in comparable terms with non-scientists. Moreover, interview data appear to show that the critical skills needed to be effective among scientists are similar to those required by non-scientists.

Within the scientist group, as seen in Table 4.10, team leadership was the highest-scoring dimension of leadership (mean=4.53), while the lowest-scoring was communication skills (mean=4.22). The results from the qualitative FGD seem to indicate that scientists struggle with communication skills because they are not extensively trained in these areas, and their nature of work reduces the opportunity to learn social skills and interpersonal skills.

> We can find time to train doctors on how to be social, political and diplomatic. So, communication skills are important—the ability to communicate both in practical terms of writing, but also in terms of oratory. This is what I found was helpful to me because I could do what I wanted to communicate in writing…20 years ago while training as a doctor, there was no course on communication skills…It is important that we teach doctors formally how to communicate to society, not just to our individual patient, in order to negotiate and influence for better patient outcomes…because you find that a doctor has gone to the hospital and they have to be the one in charge of the Board of that facility. **9SMM—Senior Leader**

Performance on team leadership was attributed to having small neat teams with clearly defined authority lines and working methods. The significant difference in scores of ethics and accountability was attributed to the organisational culture within MAAIF, where scientists work. Specifically, as one FGD participant put it, despite the stringent government rules and procedures for financial management, a culture that permeates most public service organisations is for staff to find ways (often unethical) to supplement their low pay. Such activities were reported to include “attending unnecessary leadership workshops and organising fictitious field trips in order to obtain a training or travel allowance” (Female, Non-scientist FGD). In contrast, at URA, which has a quasi-private sector culture, the controls and processes in place for approvals minimise such fraudulent practices. A detailed and comparative look at each of the dimensions of leadership effectiveness is provided below.

Table 4.11 Role ownership

Frequency of demonstrating behaviour or skill		**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
Statement of behaviour or skill		N	%	N	%	N	%	N	%	N	%
I take personal responsibility for team failures	Scientist (n=93)	0	0.0%	2	2.2%	22	23.7%	35	37.6%	34	36.6%
	Non-Scientist (n=96)	1	1.0%	0	0.0%	15	15.6%	34	35.4%	46	47.9%
I convey an exciting and compelling view of the future	Scientist (n=93)	1	1.1%	2	2.2%	8	8.6%	39	41.9%	43	46.2%
	Non-Scientist (n=96)	0	0.0%	1	1.0%	5	5.2%	52	54.2%	38	39.6%
I ask for feedback for improvement	Scientist (n=93)	1	1.1%	1	1.1%	17	18.3%	39	41.9%	34	36.6%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	14	14.6%	48	50.0%	34	35.4%
I am aware about the organisation’s strengths and weaknesses	Scientist (n=93)	0	0.0%	0	0.0%	6	6.5%	39	41.9%	48	51.6%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	6	6.3%	39	40.6%	51	53.1%
I approach my work with enthusiasm	Scientist (n=93)	0	0.0%	0	0.0%	7	7.5%	22	23.7%	64	68.8%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	2	2.1%	37	38.5%	57	59.4%
I demonstrate technical competence in my area	Scientist (n=93)	0	0.0%	0	0.0%	5	5.4%	28	30.1%	60	64.5%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	1	1.0%	30	31.3%	65	67.7%

Table 4.11 appears to indicate that a comparable proportion of scientists and non-scientist believe they often take personal responsibility for team failures, although more non-scientists (47.9%) compared to scientists (36.6%) believe they always do so. The majority of scientists and non-scientists (78.5% and 85.4%, respectively) selected either often or always when asked about the frequency of demonstrating the skill of asking for feedback for improvement. The implication of the result could be that both groups can leverage such feedback in their leader development journey and improve overall effectiveness. As seen in Table 4.11 a slightly higher proportion of non-scientists (99%) perceive themselves to be often or always demonstrating technical competence in their area compared to scientists (94.6%). That scientists appear to be less frequent than non-scientists in their demonstration of technical competence could be considered surprising.

Table 4.12 Emotional intelligence

Frequency of demonstrating behaviour or skill		Never		Seldom		Sometimes		Often		Always	
Statement of behaviour or skill		N	%	N	%	N	%	N	%	N	%
I am sensitive to the feelings of others	Scientist (n=93)	0	0.0%	1	1.1%	10	10.8%	29	31.2%	53	57.0%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	5	5.2%	38	39.6%	53	55.2%
I see situations from the others' perspective	Scientist (n=92)	1	1.1%	0	0.0%	22	23.9%	48	52.2%	21	22.8%
	Non-Scientist (n=95)	0	0.0%	0	0.0%	15	15.8%	42	44.2%	38	40.0%
I am approachable	Scientist (n=92)	0	0.0%	0	0.0%	7	7.6%	15	16.3%	70	76.1%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	6	6.3%	29	30.2%	61	63.5%
I treat others with dignity and respect	Scientist (n=92)	0	0.0%	1	1.1%	2	2.2%	15	16.3%	74	80.4%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	0	0.0%	16	16.7%	80	83.3%
I am aware of how my behaviour affects others	Scientist (n=93)	0	0.0%	0	0.0%	17	18.3%	37	39.8%	39	41.9%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	7	7.3%	43	44.8%	46	47.9%
I stay calm in difficult situations	Scientist (n=93)	0	0.0%	2	2.2%	12	12.9%	48	51.6%	31	33.3%
	Non-Scientist (n=96)	0	0.0%	1	1.0%	15	15.6%	46	47.9%	34	35.4%

Table 4.12 above appears to show that scientists were comparable to non-scientists in their perception of the frequency of demonstrating leadership behaviour related to emotional intelligence. Most scientists perceive that they frequently demonstrate sensitivity to the feelings of others (31.2% often, 57.0% always). Similarly, majority report high frequency in demonstrating seeing things from others' perspective (52.2% often, 22.8% always), demonstrating approachability (16.3% often, 76.1% always), treating others with dignity and respect (16.3% often, 80.4% always), and in demonstrating calmness in difficult situations (51.6% often, 33.3% always). On demonstrating awareness of how one's behaviour affects others—a key aspect of emotional intelligence—81.7% (39.8% often, 41.9% always) scientists compared to 92.7% (44.8% often, 47.9% always) of non-scientist perceived the frequency of demonstrating such behaviour as high. Moreover, qualitative interviews from senior leaders among scientists consistently showed that such leaders had struggled with self-awareness, interpersonal relationships and emotional intelligence but that with intentionality, training and feedback, they got better at it.

> There's always a need to be emotionally intelligent and be able to manage those around you...In my early career I struggled to understand why some of my direct reports just didn't understand simple concepts, until my manager called me in the office and told me 'You're not the same and your success is only as good as you being able to translate what you're saying so that the other person understands, however long it takes them to understand.' That for me was a moment of truth, of realising, 'Oh, we are different or we need to take it slow, because as much as it takes me maybe five minutes to understand something, it might take another person one hour

and my duty is to be able to actually help them get it for us to succeed together. And so, for me, it was a moment of self-awareness and others' awareness…which helped me to be able to influence, lead and support the team better. But unless I had got that feedback and that realisation, I would still be locked into my mindset, shouting at people, 'Why are you being too slow to show that again?' Sorry, I was rude. So, it's very important for us to be self-aware if we are going to grow as leaders. **16SEM—Middle Manager**

Given the demographics of the scientists responding to the study where senior leaders were the majority, and participants' recounting of their development journey, the results appear to imply that scientists in senior roles similarly demonstrate essential soft skills such as emotional intelligence like their non-scientist counterparts and that with time, these skills can be learned by the scientists' community.

Table 4.13 Servant leadership

Frequency of demonstrating behaviour or skill		**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
Statement of behaviour or skill		N	%	N	%	N	%	N	%	N	%
I model the behaviours I expect of others	Scientist (n=93)	0	0.0%	2	2.2%	12	12.9%	48	51.6%	31	33.3%
	Non-Scientist (n=96)	0	0.0%	1	1.0%	12	12.5%	36	37.5%	47	49.0%
I act with humility	Scientist (n=93)	0	0.0%	1	1.1%	10	10.8%	28	30.1%	54	58.1%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	6	6.3%	35	36.5%	55	57.3%
I sacrifice personal interests for the success of others	Scientist (n=93)	0	0.0%	1	1.1%	19	20.4%	47	50.5%	26	28.0%
	Non-Scientist (n=96)	0	0.0%	1	1.0%	16	16.7%	48	50.0%	31	32.3%
I constantly look for ways to add value to others	Scientist (n=93)	0	0.0%	1	1.1%	7	7.5%	34	36.6%	51	54.8%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	8	8.3%	41	42.7%	47	49.0%
I demonstrate commitment to personal values	Scientist (n=93)	0	0.0%	1	1.1%	8	8.6%	27	29.0%	57	61.3%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	3	3.1%	32	33.3%	61	63.5%
I seek out coaching and advice	Scientist (n=93)	0	0.0%	4	4.3%	16	17.2%	37	39.8%	36	38.7%
	Non-Scientist (n=96)	0	0.0%	1	1.0%	9	9.4%	49	51.0%	37	38.5%

Table 4.13 above seems to show that servant leadership is not frequently practised by scientist as compared to non-scientist leaders. While no respondent believed they never practised any of the behaviours, only 33.3% of scientists compared to 49.0% non-scientists perceived to have always demonstrated modelling the behaviour they expect of others. Only 28% of scientists compared to 32.3% non-scientists perceived themselves as always putting personal interest aside to pursue others' success. The results also show that 88.2% (30.1% often, 58.1% always) of scientists compared to 93.8% (36.5% often, 57.3% always) of non-scientists perceived themselves to act with humility with high frequency. This result contrasts with the findings from the qualitative interviews where scientists in senior technical roles are reported to lead with technical authority and 'percussion' of others below them. The

implication could be that while senior scientist leaders may have grown in demonstrating leadership effectiveness, many do not realise the impact of their leadership styles on others and might therefore perceive themselves to demonstrate leadership behaviours higher than others might see them—thereby heightening the need for feedback and self-awareness as critical leader development approaches.

Table 4.14 Strategic thinking

Frequency of demonstrating behaviour or skill		**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
Statement of behaviour or skill		N	%	N	%	N	%	N	%	N	%
I act with a clear purpose	Scientist (n=93)	0	0.0%	0	0.0%	6	6.5%	40	43.0%	47	50.5%
	Non-Scientist (n=94)	0	0.0%	0	0.0%	4	4.3%	43	45.7%	47	50.0%
I prefer to ask why questions to develop an understanding of problems	Scientist (n=93)	0	0.0%	3	3.2%	15	16.1%	39	41.9%	36	38.7%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	9	9.4%	48	50.0%	39	40.6%
I ignore past decisions when considering current similar situations (r)	Scientist (n=91)	8	8.8%	8	8.8%	30	33.0%	26	28.6%	19	20.9%
	Non-Scientist (n=96)	3	3.1%	15	15.6%	31	32.3%	36	37.5%	11	11.5%
I understand diverse changes in the internal and external environment of the organisation	Scientist (n=92)	0	0.0%	1	1.1%	16	17.4%	47	51.1%	28	30.4%
	Non-Scientist (n=96)	0	0.0%	1	1.0%	10	10.4%	52	54.2%	33	34.4%
I consider how I could have handled the situation after it was resolved	Scientist (n=90)	5	5.6%	10	11.1%	32	35.6%	24	26.7%	19	21.1%
	Non-Scientist (n=96)	2	2.1%	10	10.4%	24	25.0%	42	43.8%	18	18.8%
Seeing the big picture comes easily for me	Scientist (n=93)	1	1.1%	0	0.0%	12	12.9%	42	45.2%	38	40.9%
	Non-Scientist (n=96)	0	0.0%	2	2.1%	7	7.3%	46	47.9%	41	42.7%

The results in Table 4.14 show that majority of scientists (43.0% often, 50.5% always) and non-scientists (45.7% often, 50.0% always) perceived themselves to frequently demonstrate acting with a clear purpose. Similarly, a high proportion of scientists and non-scientist frequently demonstrate asking 'why' questions with the combined proportion reporting often and always at 80.6% and 90.6% respectively. The majority of respondents report frequently demonstrating understanding diverse changes in their operating environment with a combined proportion that report a frequency of often and always at 81.5% of scientists and 88.6% of non-scientists. The combined proportion reporting the frequency in demonstrating seeing the big picture easily as often and always was 86.1% of scientists and 90.6% of non-scientists. However, both groups seem to struggle with the practice of reflection on how they could have handled a resolved situation, with only 47.8% of scientists (26.7% often, 21.1% always) and 62.6% of non-scientists (43.8% often, 18.8% always) reporting high frequency in demonstrating this behaviour. Notably, only 21.1% of scientists and 18.8% non-scientist perceive that such a practice is consistent. Relatedly, only 20.9% of scientists and 11.5% of non-scientists believe that they always consider past decisions when addressing similar circumstances. More so, about a third suggested that they sometimes ignore past decisions, sometimes they do not, and slightly more than a third of scientists rate their frequency in reflecting on a situation after handling it also as fifty-fifty.

The implication of the results might be that both groups could benefit greatly in adopting after-action review activities and reflection methodologies such as action learning in their leader development. Specifically, as evidenced by the participant voices below, the practice of reflection is counter-cultural for scientists' organisations and should be deliberately encouraged.

> This is a government way of doing business across all ministries where ministries and their agencies usually organise to review what has been achieved, but unfortunately only the technical and financial investment is evaluated. So, the leadership evaluation does not come out at these annual reviews as much as it should. **7SAM—Senior Leader**

> …the way reviews are structured, their impact on how we can measure or influence changes in leadership is very minimal…especially because people don't like to hear critical opinions however constructive they might be. **12SAM—Senior Leader**

> I believe because of our medical training, you find you only do a post-mortem if things go wrong, then you have to go and see where things went wrong…but we rarely do it say to improve conflict management, communication, expectation management, listening…you find that when you do a post-mortem on a project, people want to find where did we go wrong and start a blame game…get the evidence as to who did this and who didn't do that. **7SMF—Senior Leader**

Table 4.15 Ethics and accountability

Frequency of demonstrating behaviour or skill		**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
Statement of behaviour or skill		N	%	N	%	N	%	N	%	N	%
I am open and transparent	Scientist (n=93)	0	0.0%	0	0.0%	6	6.5%	22	23.7%	65	69.9%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	2	2.1%	34	35.4%	60	62.5%
I act consistently with my core values	Scientist (n=93)	0	0.0%	0	0.0%	5	5.4%	27	29.0%	61	65.6%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	3	3.1%	31	32.3%	62	64.6%
People can count on me to do the right thing even when it won't be popular	Scientist (n=92)	1	1.1%	0	0.0%	12	13.0%	32	34.8%	47	51.1%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	3	3.1%	20	20.8%	73	76.0%
I am honest and straightforward	Scientist (n=93)	0	0.0%	1	1.1%	6	6.5%	26	28.0%	60	64.5%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	2	2.1%	21	21.9%	73	76.0%
I follow through on my commitments	Scientist (n=93)	1	1.1%	0	0.0%	2	2.2%	32	34.4%	58	62.4%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	2	2.1%	32	33.3%	62	64.6%
I am aware of my strengths and shortcomings	Scientist (n=91)	0	0.0%	1	1.1%	5	5.5%	39	42.9%	46	50.5%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	2	2.1%	38	39.6%	56	58.3%

Results in Table 4.15 above seem to show that both scientists and non-scientists report that they frequently and consistently demonstrate behaviours such as openness and transparency, honesty, following through with commitments, an awareness and acceptance of their strengths and shortcomings, and doing the right thing even when it might be unpopular. This appears to demonstrate high levels of perceived ethics and accountability in leadership. Nonetheless, for the behaviour of being counted on to do the right thing even when it might not be popular, a higher proportion of non-scientists than scientists rated their frequency of demonstrating such behaviour as consistent (76% and 51.1%, respectively). Even more, 13% of scientists perceive that sometimes they can be counted on, sometimes not. As presented earlier, qualitative interviews specifically single out the accountability culture and leadership styles in their respective organisations as one reason why such a dimension of leadership effectiveness may be different between scientists and non-scientists.

Table 4.16 Performance management

Frequency of demonstrating behaviour or skill		**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
Statement of behaviour or skill		N	%	N	%	N	%	N	%	N	%
I communicate crystal clear plans and strategies	Scientist (n=93)	0	0.0%	1	1.1%	5	5.4%	43	46.2%	44	47.3%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	4	4.2%	42	43.8%	50	52.1%
I hold others accountable for their performance	Scientist (n=93)	1	1.1%	0	0.0%	22	23.7%	32	34.4%	38	40.9%
	Non-Scientist (n=95)	0	0.0%	0	0.0%	7	7.4%	37	38.9%	51	53.7%
I provide well-intentioned performance feedback	Scientist (n=93)	0	0.0%	1	1.1%	6	6.5%	32	34.4%	54	58.1%
	Non-Scientist (n=95)	0	0.0%	0	0.0%	4	4.2%	38	40.0%	53	55.8%
I help the team excel and produce results	Scientist (n=93)	0	0.0%	1	1.1%	5	5.4%	36	38.7%	51	54.8%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	3	3.1%	36	37.5%	57	59.4%
I encourage people to make improvements in their work	Scientist (n=91)	1	1.1%	0	0.0%	7	7.7%	27	29.7%	56	61.5%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	2	2.1%	35	36.5%	59	61.5%
When dealing with subordinates, I can be tough or supportive depending on what the situation demands	Scientist (n=93)	0	0.0%	3	3.2%	17	18.3%	32	34.4%	41	44.1%
	Non-Scientist (n=94)	0	0.0%	0	0.0%	13	13.8%	41	43.6%	40	42.6%

The results in Table 4.16 appear to show that when it comes to performance management, most respondents are perceived to be demonstrating the expected behaviours frequently. In some cases, such as holding people accountable, providing feedback, helping the team to excel, encouraging people to improve in the work, more than half of the respondents suggested they do so consistently. For both the scientists and non-scientists, situational leadership scored lower than other areas. For insistence, 44.1% of scientists and 42.6% of non-scientist expressed consistency in how they adapt to situational demands to be tough or supportive. Thereupon, it might be considered not surprising that nearly a quarter (23.7%) of scientists seem unsure of frequently holding others accountable for performance, rating their perception of demonstrating the behaviour as, sometimes. The implication could be that leader development approaches that address situational leadership and grow the leader's comfort in holding subordinates accountable for performance, such as self-awareness, coaching, mentoring, feedback and formal training, could be relevant to improvements in this area.

Table 4.17 Decision making and problem solving

Frequency of demonstrating behaviour or skill		**Never**		**Seldom**		**Sometimes**		**Often**		**Always**	
Statement of behaviour or skill		N	%	N	%	N	%	N	%	N	%
I treat mistakes, errors, and setbacks as valuable learning experiences	Scientist (n=93)	0	0.0%	0	0.0%	12	12.9%	34	36.6%	47	50.5%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	7	7.3%	41	42.7%	48	50.0%
I own up to the decisions I make	Scientist (n=93)	0	0.0%	0	0.0%	5	5.4%	26	28.0%	62	66.7%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	1	1.0%	24	25.0%	71	74.0%
I consider many options and seek out ideas from a variety of sources before making decisions	Scientist (n=93)	0	0.0%	4	4.3%	12	12.9%	39	41.9%	38	40.9%
	Non-Scientist (n=96)	0	0.0%	1	1.0%	13	13.5%	48	50.0%	34	35.4%
In times of ambiguity and difficult change, I stay calm and positive	Scientist (n=93)	2	2.2%	1	1.1%	15	16.1%	38	40.9%	37	39.8%
	Non-Scientist (n=95)	0	0.0%	0	0.0%	13	13.7%	44	46.3%	38	40.0%
I encourage diverse points of view	Scientist (n=93)	0	0.0%	2	2.2%	18	19.4%	34	36.6%	39	41.9%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	3	3.1%	57	59.4%	36	37.5%
I think through the longer-term implications and risks of alternative courses of action before deciding which to pursue	Scientist (n=93)	0	0.0%	1	1.1%	8	8.6%	39	41.9%	45	48.4%
	Non-Scientist (n=93)	0	0.0%	1	1.1%	8	8.6%	51	54.8%	33	35.5%

The results in Table 4.17 appear to show that the majority of scientists and non-scientists consistently engage in behaviours such as using mistakes as learning opportunities and owning up to decisions. Similarly, the combined proportion of respondents reporting often or always thinking through the longer-term implications and risks of alternative courses of action before deciding which one to pursue was high with scientists at 90.3% (41.9% often, 48.4% always) and non-scientists at 90.3% (54.8% often, 35.5% always). However, when it comes to encouraging diverse points of view, staying calm and positive in times of ambiguity and change, and considering many options, ideas and sources before making a decision, some scientists and non-scientists suggest that they sometimes do sometimes they do not. Nearly a fifth (19.4%) of scientists seem unsure about demonstrating the behaviour of encouraging diverse points of view, as compared to only 3.1% of non-scientists. The results seem to imply that while scientists may be doing well overall in problem-solving and decision-making, not encouraging diverse points of view might limit their ability to tap into the team's collective intelligence.

Table 4.18 Team leadership

Frequency of demonstrating behaviour or skill		Never		Seldom		Sometimes		Often		Always	
Statement of behaviour or skill		N	%	N	%	N	%	N	%	N	%
I empower and develop others	Scientist (n=93)	0	0.0%	1	1.1%	4	4.3%	33	35.5%	55	59.1%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	3	3.1%	38	39.6%	55	57.3%
I am a positive influence on the energy and motivation of my team	Scientist (n=93)	0	0.0%	0	0.0%	4	4.3%	38	40.9%	51	54.8%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	5	5.2%	33	34.4%	58	60.4%
I appreciate individuals for their contribution to the team	Scientist (n=93)	0	0.0%	0	0.0%	3	3.2%	26	28.0%	64	68.8%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	2	2.1%	16	16.7%	78	81.3%
I create a sense that each person's job is significant and important	Scientist (n=93)	0	0.0%	0	0.0%	2	2.2%	22	23.7%	69	74.2%
	Non-Scientist (n=95)	0	0.0%	0	0.0%	0	0.0%	20	21.1%	75	78.9%
I foster team cohesion	Scientist (n=93)	0	0.0%	2	2.2%	6	6.5%	28	30.1%	57	61.3%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	3	3.1%	25	26.0%	68	70.8%
I work hard to find consensus in conflict situations	Scientist (n=93)	1	1.1%	1	1.1%	10	10.8%	39	41.9%	42	45.2%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	4	4.2%	50	52.1%	42	43.8%

The results in Table 4.18 appear to show that both scientists and non-scientists perceive themselves to regularly and consistently demonstrate behaviours that improve team leadership. The majority of respondents suggested that they always demonstrate behaviours such as empowering and developing others, positively influencing the team, appreciating individuals for their contribution, creating a sense that each person is valued and fostering team cohesion. However, working hard to find consensus in conflict situations scored lowest, with only 45.2% of scientists and 43.8% of non-scientists reporting that they consistently demonstrate the behaviour. Moreover, 10.8% of scientists reported that they do so sometimes and sometimes they do not. Given that considerably fewer scientists than non-scientists score highly on the consistency of appreciating individuals for their contribution to the team (68.8% versus 81.3% respectively), the implication could be that finding consensus in conflict situations might be made even more difficult for scientists. As evidenced in the foregoing qualitative results presented on attitude and contextual influences in section 4.3 above, the leader identity, social identity and conceptualisation of leadership among scientists appears to affect the way they approach consensus building and the welcoming of diverse views, especially if such views are obtaining from technically junior officers—issues that diminish the team leadership capabilities of scientists.

Table 4.19 Communication skills

Frequency of demonstrating behaviour or skill		Never		Seldom		Sometimes		Often		Always	
Statement of behaviour or skill		N	%	N	%	N	%	N	%	N	%
I am able to sense the emotional undercurrents in my group	Scientist (n=92)	1	1.1%	0	0.0%	14	15.2%	47	51.1%	30	32.6%
	Non-Scientist (n=95)	0	0.0%	0	0.0%	12	12.6%	48	50.5%	35	36.8%
I am content with the way my communication with my co-workers is going	Scientist (n=92)	0	0.0%	2	2.2%	16	17.4%	50	54.3%	24	26.1%
	Non-Scientist (n=96)	0	0.0%	2	2.1%	12	12.5%	54	56.3%	28	29.2%
My co-workers and I can speak openly with one another	Scientist (n=93)	1	1.1%	2	2.2%	8	8.6%	32	34.4%	50	53.8%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	8	8.3%	32	33.3%	56	58.3%
I encourage inquiries from subordinates concerning clarification of the decision being made	Scientist (n=93)	0	0.0%	1	1.1%	13	14.0%	35	37.6%	44	47.3%
	Non-Scientist (n=96)	0	0.0%	0	0.0%	5	5.2%	30	31.3%	61	63.5%
I listen attentively to others' concerns	Scientist (n=93)	0	0.0%	1	1.1%	8	8.6%	31	33.3%	53	57.0%
	Non-Scientist (n=96)	0	0.0%	1	1.0%	4	4.2%	34	35.4%	57	59.4%
I argue persuasively for my point of view	Scientist (n=93)	0	0.0%	3	3.2%	25	26.9%	37	39.8%	28	30.1%
	Non-Scientist (n=96)	0	0.0%	5	5.2%	28	29.2%	36	37.5%	27	28.1%

The results in Table 4.19 appear to show that compared to other dimensions of leadership effectiveness, fewer respondents believe that they consistently demonstrate behaviours associated with communication skills. Only 32.6% of scientists and 36.8% of non-scientists believe that they are consistently able to sense the emotional undercurrents in their team, with some 15.2% of scientists and 12.6% of non-scientists reporting the frequency of doing so as, sometimes. Only 26.1% of scientists and 29.2% of non-scientists report being consistently content with the way communication with co-workers is going. Furthermore, only 30.1% of scientists and 28.1% of non-scientists report consistently demonstrating the ability to argue persuasively for their point of view. Moreover, slightly more than a quarter (26.9% of scientists and 29.2% of non-scientists) report arguing persuasively, only sometimes. The implication of the results seem to be that both groups of leaders may benefit more from leader development activities targeting improvement in communication skills.

Table 4.20 Innovation and creativity

Frequency of demonstrating behaviour or skill		Never		Seldom		Sometimes		Often		Always	
Statement of behaviour or skill		N	%	N	%	N	%	N	%	N	%
I challenge the status quo by exploring new ways to achieve goals and overcome obstacles, and I encourage others to do the same	Scientist (n=93)	0	0.0%	1	1.1%	22	23.7%	37	39.8%	33	35.5%
	Non-Scientist (n=94)	0	0.0%	3	3.2%	12	12.8%	39	41.5%	40	42.6%
I constantly search for ways to improve existing processes and approaches	Scientist (n=93)	1	1.1%	2	2.2%	8	8.6%	38	40.9%	44	47.3%
	Non-Scientist (n=96)	0	0.0%	2	2.1%	11	11.5%	43	44.8%	40	41.7%
I make adequate time available to pursue create ideas	Scientist (n=92)	1	1.1%	0	0.0%	18	19.6%	43	46.7%	30	32.6%
	Non-Scientist (n=96)	0	0.0%	2	2.1%	22	22.9%	48	50.0%	24	25.0%
I encourage creative ways to solve problems	Scientist (n=93)	0	0.0%	1	1.1%	2	2.2%	37	39.8%	53	57.0%
	Non-Scientist (n=95)	0	0.0%	1	1.1%	6	6.3%	38	40.0%	50	52.6%
I provide my team with opportunities for development and displaying talent even when I know they will make mistakes as they try new things	Scientist (n=93)	2	2.2%	0	0.0%	13	14.0%	43	46.2%	35	37.6%
	Non-Scientist (n=94)	0	0.0%	2	2.1%	17	18.1%	33	35.1%	42	44.7%
I don't take credit for other people's ideas	Scientist (n=93)	12	12.9%	10	10.8%	10	10.8%	17	18.3%	44	47.3%
	Non-Scientist (n=96)	9	9.4%	7	7.3%	7	7.3%	14	14.6%	59	61.5%

The results in Table 4.20 appear to indicate that when it comes to behaviours that depict innovation and creativity, both scientists and non-scientists demonstrate them fairly frequently. On regular searching for ways to improve existing processes and approaches, 88.2% of scientists (40.9% often, 47.3% always) and 86.5% of non-scientists (44.8% often, 41.7% always) report doing so highly frequently. Similarly, both scientists and non-scientists frequently demonstrate behaviours such as encouraging creative ways to solve problems, with the combined proportion reporting often and always at 96.8% and 92.6%, respectively. However, a larger proportion of non-scientists (42.6%) compared to scientists (35.5%) consistently challenges the status quo by exploring new ways to achieve goals. Moreover, nearly a quarter of scientists (23.7%) compared to non-scientists (12.8%) report only doing so sometimes.

Furthermore, about a fifth of respondents in both groups report making adequate time available to pursue creative ideas only sometimes. Moreover, only 32.6% of scientists and 25.0% of non-scientists report consistently making adequate time to pursue creative ideas. Furthermore, only 65.6% of scientists compared to 76.1% of non-scientists reported frequently not taking credit for other people's ideas—with what could be considered a surprising proportion of scientists reporting never (12.9%) and seldom

(10.8%) demonstrating the behaviour of not taking credit for other people's ideas. The implication of the results seem to be that scientists need to engage in leader development activities that encourage collaboration as a means for improving innovation.

4.5.2 Exposure to leader development

Respondents were asked to rate their exposure to leader development approaches by selecting how much they have participated in any of the ten leader development approached under study. On a scale of 1 (not participated at all) to 5 (Primary activity for my development), respondents outlined their level of engagement in each of the activities, as shown in Table 4.21 below.

Table 4.21 Exposure to leader development

	Scientist (n=93)	*Non-scientist (n=96)*	*F*	*Sig.*
Coaching	2.66	2.89	1.221	0.271
Mentorship	3.42	3.74	3.301	0.071
Feedback	3.66	3.63	0.047	0.828
Experiential learning	4.33	3.94	6.507	**0.012**
e-Learning	3.49	3.50	0.001	0.973
Formal leadership training	3.37	3.53	0.539	0.464
Networking	3.46	3.62	0.714	0.399
Leadership roles	3.90	4.10	1.617	0.205
Self-directed learning	3.83	4.05	1.862	0.174
Self-awareness	3.50	3.69	1.131	0.289

The results in Table 4.21 appear to show no significant differences in exposure to leader development approaches between scientists and non-scientists, except for experiential learning. Scientists (mean=4.33) reported a statistically significantly higher mean score for experiential learning than non-scientists (mean=3.94), $p<0.05$. The results seem to imply that experiential learning is a more popular approach for leader development among scientists than non-scientists. This is consistent with the findings in the qualitative interviews and FGDs, where many scientists highlighted that they had learned leadership mostly on the job.

As seen in Table 4.21 above, it appears that within the scientists' group, the approaches that leaders were most exposed to included experiential learning, acting in leadership roles, self-directed learning and feedback. The approaches scientists were least exposed to included coaching, formal leadership training, mentorship and networking. A cross tabulation of proportions using the Z-test was conducted to examine the differences in levels of participation/exposure between the two groups and the results are highlighted in the tables below.

4.5.2.1 Coaching

Table 4.22 Exposure to coaching

Extent of exposure to coaching	**Scientist**		**Non-Scientist**		**Total**	
	N	%	N	%	N	%
Not participated in this at all	26_a	29.2%	21_a	23.9%	47	26.6%
Rarely participated	14_a	15.7%	8_a	9.1%	22	12.4%
Occasionally participated	24_a	27.0%	29_a	33.0%	53	29.9%
Moderately a feature of my development	14_a	15.7%	20_a	22.7%	34	19.2%
Primary activity for my development	11_a	12.4%	10_a	11.4%	21	11.9%
Total	89	100.0%	88	100.0%	177	100.0%

Each subscript letter denotes exposure levels where proportions among scientists and non-scientists do not differ significantly from each other at the $p<0.05$ level.

The results in Table 4.22 appear to indicate that there were no significant differences between scientists and non-scientists on any levels of exposure to coaching. Additionally, coaching was not a well-adopted approach across groups, with only 12.4% of scientists and 11.4% of non-scientists reporting that it is their primary activity for development. As presented earlier, the qualitative interviews and FGD sentiments appear to show that this is because the approach is new in Uganda with very few professional coaches.

4.5.2.2 Mentorship

Table 4.23 Exposure to mentorship

Extent of exposure to mentorship	**Scientist**		**Non-Scientist**		**Total**	
	N	%	N	%	N	%
Not participated in this at all	7_a	7.9%	3_a	3.4%	10	5.6%
Rarely participated	15_a	16.9%	10_a	11.4%	25	14.1%
Occasionally participated	26_a	29.2%	17_a	19.3%	43	24.3%
Moderately a feature of my development	16_a	18.0%	35_b	39.8%	51	28.8%
Primary activity for my development	25_a	28.1%	23_a	26.1%	48	27.1%
Total	89	100.0%	88	100.0%	177	100.0%

Each subscript letter denotes exposure levels where proportions among scientists and non-scientists do not differ significantly from each other at the $p<0.05$ level.

Table 4.23 above seems to show that there was only a significant difference in exposure levels between the scientists and non-scientists that report using mentorship as a moderate feature for their leader development. A higher proportion of non-scientists (39.8%) than scientists (18%) significantly used mentorship as a moderate feature of their leader development. The implication of the results could be that given the power of mentorship in leader development, the approach needs to be encouraged and promoted as it is one of the least embraced activity among scientists.

4.5.2.3 Feedback

Table 4.24 Exposure to feedback

Extent of exposure to feedback	**Scientist**		**Non-Scientist**		**Total**	
	N	%	N	%	N	%
Not participated in this at all	6_a	6.7%	3_a	3.4%	9	5.1%
Rarely participated	12_a	13.5%	9_a	10.2%	21	11.9%
Occasionally participated	15_a	16.9%	28_b	31.8%	43	24.3%
Moderately a feature of my development	29_a	32.6%	26_a	29.5%	55	31.1%
Primary activity for my development	27_a	30.3%	22_a	25.0%	49	27.7%
Total	89	100.0%	88	100.0%	177	100.0%

Each subscript letter denotes exposure levels where proportions among scientists and non-scientists do not differ significantly from each other at the $p<0.05$ level.

The results in Table 4.24 seem to indicate that just above a quarter of respondents (27.7%) used feedback as their primary activity for development. Additionally, a higher proportion of non-scientists (31.8%) than scientists (16.9%) reported having occasionally used feedback for their development. There were no significant differences between the two groups in other levels of exposure. The results seem to imply that both scientists and non-scientists can benefit from an increased engagement with feedback.

4.5.2.4 Experiential learning

Table 4.25 Exposure to experiential learning

Extent of exposure to experiential learning	Scientist		Non-Scientist		Total	
	N	%	N	%	N	%
Not participated in this at all	3_a	3.4%	4_a	4.5%	7	4.0%
Rarely participated	2_a	2.2%	2_a	2.3%	4	2.3%
Occasionally participated	9_a	10.1%	17_a	19.3%	26	14.7%
Moderately a feature of my development	24_a	27.0%	37_b	42.0%	61	34.5%
Primary activity for my development	51_a	57.3%	28_b	31.8%	79	44.6%
Total	89	100.0%	88	100.0%	177	100.0%

Each subscript letter denotes exposure levels where proportions among scientists and non-scientists do not differ significantly from each other at the $p<0.05$ level.

The results in Table 4.25 appear to show that a significantly higher proportion of scientists (57.3%) than non-scientists (31.8%) used experiential learning as the primary activity for their leader development. Very few scientists (3.4%) reported not participating in experiential learning, highlighting how popular the approach is. The implication of the result could be that given that most scientist leaders have participated substantially in experiential learning to nurture leadership skills, efforts should be made to improve how experiential learning is approached to bring more effectiveness to scientist leaders.

4.5.2.5 E-learning

Table 4.26 Exposure to e-learning

Extent of exposure to e-learning	Scientist		Non-Scientist		Total	
	N	%	N	%	N	%
Not participated in this at all	6_a	6.7%	8_a	9.1%	14	7.9%
Rarely participated	9_a	10.1%	10_a	11.4%	19	10.7%
Occasionally participated	32_a	36.0%	21_a	23.9%	53	29.9%
Moderately a feature of my development	19_a	21.3%	28_a	31.8%	47	26.6%
Primary activity for my development	23_a	25.8%	21_a	23.9%	44	24.9%
Total	89	100.0%	88	100.0%	177	100.0%

Each subscript letter denotes exposure levels where proportions among scientists and non-scientists do not differ significantly from each other at the $p<0.05$ level.

The results in Table 4.26 appear to show that the majority of scientists have only occasionally participated in e-learning based programmes for leader development. Only 25.8% have relied upon this method as their primary activity for development. The results also seem to show no significant differences between scientists and non-scientists in their levels of exposure to the e-learning approach. The results might imply that given the disruptions that COVID-19 has made to face-to-face modes of learning, e-learning could be explored among scientists.

4.5.2.6 Formal leadership training

Table 4.27 Exposure to formal leadership training

Extent of exposure to formal leadership training	Scientist		Non-Scientist		Total	
	N	%	N	%	N	%
Not participated in this at all	13_a	14.6%	14_a	16.1%	27	15.3%
Rarely participated	13_a	14.6%	7_a	8.0%	20	11.4%
Occasionally participated	18_a	20.2%	13_a	14.9%	31	17.6%
Moderately a feature of my development	18_a	20.2%	25_a	28.7%	43	24.4%
Primary activity for my development	27_a	30.3%	28_a	32.2%	55	31.3%
Total	89	100.0%	87	100.0%	176	100.0%

Each subscript letter denotes exposure levels where proportions among scientists and non-scientists do not differ significantly from each other at the $p<0.05$ level.

The results in Table 4.27 appear to show that there were no significant differences in the levels of exposure to formal leadership training among scientists and non-scientists. Among scientists, only 30.3% reported being exposed to formal leadership training as their primary development activity. Noteworthy is that 14.6% of the leaders among scientists reported never having participated in formal leadership training, and an equal proportion has only rarely participated in the approach for their development. Considering the scientists' group demographics as presented in Table 4.2—where 50.9% were in senior management or executive director roles, 75.5% had completed either a masters or doctorate qualification, and 44.3% were 50 years and older—formal leadership training programmes seem not to have been an important feature of leader development. The findings seem to imply that more leadership training programmes should be instituted at the start of the pipeline for early-career scientists.

4.5.2.7 Networking

Table 4.28 Exposure to networking

Extent of exposure to networking	Scientist		Non-Scientist		Total	
	N	%	N	%	N	%
Not participated in this at all	8_a	9.0%	5_a	5.8%	13	7.4%
Rarely participated	11_a	12.4%	10_a	11.6%	21	12.0%
Occasionally participated	26_a	29.2%	21_a	24.4%	47	26.9%
Moderately a feature of my development	20_a	22.5%	27_a	31.4%	47	26.9%
Primary activity for my development	24_a	27.0%	23_a	26.7%	47	26.9%
Total	89	100.0%	86	100.0%	175	100.0%

Each subscript letter denotes exposure levels where proportions among scientists and non-scientists do not differ significantly from each other at the $p<0.05$ level.

The results in Table 4.28 appear to show that there were no significant differences in the way scientist and non-scientist leaders were exposed to networking as a form of leader development. Among scientists, 27% used networking as their primary activity for development, 22.5% moderately participated, while 12.4% rarely participated in the approach.

4.5.2.8 Leadership roles

Table 4.29 Exposure to acting in leadership roles

Extent of exposure to leadership roles	Scientist		Non-Scientist		Total	
	N	%	N	%	N	%
Not participated in this at all	4_a	4.5%	1_a	1.2%	5	2.9%
Rarely participated	6_a	6.7%	7_a	8.1%	13	7.4%
Occasionally participated	19_a	21.3%	12_a	14.0%	31	17.7%
Moderately a feature of my development	26_a	29.2%	28_a	32.6%	54	30.9%
Primary activity for my development	34_a	38.2%	38_a	44.2%	72	41.1%
Total	89	100.0%	86	100.0%	175	100.0%

Each subscript letter denotes exposure levels where proportions among scientists and non-scientists do not differ significantly from each other at the $p<0.05$ level.

Table 4.29 above seems to indicate that 38.2% of scientists were exposed to acting in a leadership role as their primary activity for their development while 29.2% and 21.3% moderately and occasionally participated in the approach, respectively. There were no significant differences in the exposure to acting in leadership roles between scientists and non-scientists. The results seem to imply that acting in leadership roles is popular among scientists, as corroborated in the qualitative data presented earlier.

4.5.2.9 Self-directed learning

Table 4.30 Exposure to self-directed learning

Extent of exposure to self-directed learning	**Scientist**		**Non-Scientist**		**Total**	
	N	%	N	%	N	%
Not participated in this at all	1_a	1.2%	2_a	2.3%	3	1.7%
Rarely participated	12_a	14.0%	8_a	9.1%	20	11.5%
Occasionally participated	16_a	18.6%	10_a	11.4%	26	14.9%
Moderately a feature of my development	29_a	33.7%	32_a	36.4%	61	35.1%
Primary activity for my development	28_a	32.6%	36_a	40.9%	64	36.8%
Total	86	100.0%	88	100.0%	174	100.0%

Each subscript letter denotes exposure levels where proportions among scientists and non-scientists do not differ significantly from each other at the $p<0.05$ level.

The results in Table 4.30 appear to show that 66.3% of scientists engaged in self-directed learning as a major part of their leader development activities. Only 1.2% did not participate in the approach, 14% rarely participated in it, and 18.6% occasionally participated. There were no significant differences in the exposure levels to self-directed learning between scientists and non-scientists.

4.5.2.10 Self-awareness

Table 4.31 Exposure to self-awareness

Extent of exposure to self-awareness	**Scientist**		**Non-Scientist**		**Total**	
	N	%	N	%	N	%
Not participated in this at all	8_a	9.1%	6_a	6.8%	14	8.0%
Rarely participated	10_a	11.4%	7_a	8.0%	17	9.7%
Occasionally participated	19_a	21.6%	23_a	26.1%	42	23.9%
Moderately a feature of my development	32_a	36.4%	24_a	27.3%	56	31.8%
Primary activity for my development	19_a	21.6%	28_a	31.8%	47	26.7%
Total	88	100.0%	88	100.0%	176	100.0%

Each subscript letter denotes exposure levels where proportions among scientists and non-scientists do not differ significantly from each other at the $p<0.05$ level.

The results in Table 4.31 appear to show that only 21.6% of scientists engaged in self-awareness as a primary activity for their development, and an equal number used it occasionally, while the majority (36.4%) had self-awareness activities as a moderate feature of their development. There were no significant differences in the exposure levels to self-awareness between scientists and non-scientists.

4.6 Objective 4: Approaches that engender leadership effectiveness

Objective four aimed to explore leader development approaches and practices associated with higher leadership effectiveness in order to recommend leader development approaches that are likely to lead to leader effectiveness among natural scientists. This section looks at the relationship between leader development approaches and leadership effectiveness as an intermediate step towards identifying the critical leader development approaches.

Table 4.32 below shows the dose-response relationship between leader development and leadership effectiveness. It presents the proportion of survey respondents who had high leadership effectiveness for each level of exposure to specific leader development approaches after adjusting for age, education, levels of seniority and the comparison group (scientist/non-scientist). The univariate analysis of variance also used an F-test and pairwise comparisons to examine the effects of each leader development approach and thereby determine whether various levels of exposure to such a leader development activity were associated with high levels of leadership effectiveness (between-subjects effects). Where statistically significant differences were detected ($p<0.05$) between levels of exposure and demonstration of high leadership effectiveness, these are shown in the table with bold type and superscript annotation.

Table 4.32 Dose-response relationship between leader development and leadership effectiveness

Leader Development Approach (N=155)	*No Exposure %*	*Low Exposure %*	*High Exposure %*	*F*	*Sig.*
Coaching	47.8^{a}	51.5^{a}	57.1^{a}	0.407	0.667
Mentorship	56.7^{a}	40.1^{a}	60.5^{b}	3.072	**0.049**
Feedback	27.7^{a}	36.8^{a}	64.0^{b}	6.700	**0.002**
Experiential learning	22.5^{a}	40.2^{a}	55.9^{a}	1.954	0.145
E-learning	23.4^{a}	47.8^{ab}	60.5^{b}	3.519	**0.032**
Formal leadership training	42.2^{ab}	35.6^{a}	63.3^{b}	5.256	**0.006**
Networking	37.2^{a}	48.7^{a}	55.9^{a}	0.711	0.493
Leadership roles	61.0^{a}	49.9^{a}	52.7^{a}	0.125	0.883
Self-directed learning	30.1^{a}	48.7^{a}	53.8^{a}	0.467	0.628
Self-awareness	37.6^{a}	54.0^{a}	53.0^{a}	0.672	0.512

a: Each superscript letter denotes exposure levels where leadership effectiveness levels do not differ significantly from each other at the $p<0.05$ level.

The results in Table 4.32 above appear to indicate that after controlling for other independent variables (age, sex and education), increasing levels of exposure to mentorship, feedback, e-learning and formal leadership training are associated with higher leadership effectiveness. There was no significant difference in leadership effectiveness for any exposure level to coaching, experiential learning, networking, acting in leadership roles, self-directed learning or self-awareness. The results appear to show that among respondents who reported no exposure to mentorship, 56.7% exhibited high leadership effectiveness, while among those with low levels of exposure to mentorship, 40.1% demonstrated high leadership effectiveness. There were no significant differences in the demonstration of high leadership effectiveness among those reporting low exposure or no exposure to mentorship. However, when the exposure levels increase to high exposure, the proportion of those demonstrating high leadership effectiveness increased significantly to 60.5% ($p<0.05$). The implication of the finding could be that there is a dose-response relationship between mentorship and leadership effectiveness, with those highly exposed to mentorship more likely to report high effectiveness compared to those in the low exposure or no exposure category.

Similarly, whereas there was no significant difference in demonstration of high leadership effectiveness between those not exposed (27.7%) and low exposed (36.8%) to feedback, those highly exposed to feedback as a method of leader development significantly reported higher leadership effectiveness (64%, $p<0.05$). The implication could be that the more one gets feedback, the more likely to become effective in their leadership. Additionally, the results might imply that a little exposure to feedback is insufficient to lead to high leadership effectiveness and regular, intense exposure might be required to observe improvements.

Furthermore, the proportion of leaders demonstrating high leadership effectiveness among those not exposed to e-learning (23.4%) was significantly lower than those highly exposed to e-learning (60.5%). While there were no significant differences between those not exposed and those low exposed to e-learning (47.8%), higher exposure was associated with higher leadership effectiveness. This might imply that, like feedback, high exposure to e-learning might be necessary to register high leadership effectiveness, and occasional engagement with e-learning programmes might not suffice.

With formal leadership training, the proportion of leaders reporting high leadership effectiveness among those not exposed to formal training was 42.2%, while that among the low exposed and highly exposed was 35.6% and 63.3%, respectively. There were no significant differences in demonstrating leadership effectiveness between those not exposed to training and either those reporting low, or high exposure. However, there was a significant difference between those reporting low and high exposure. The results seem to imply that high exposure to formal training does not necessarily lead to higher leadership effectiveness in comparison to those not exposed at all but might be a catalyst for enhanced improvement in leadership effectiveness when incrementally adding to those somewhat exposed to training or indeed other approaches.

4.7 Chapter conclusion

This chapter presented the results using the weaving approach that triangulated and integrated findings from the quantitative survey, participant interviews and focus group discussions along emerging themes and themes predetermined by the conceptual framework. The results were presented thematically along the primary objectives that the study set out to achieve. Following academic writing convention, the results were not interpreted or meaning given in this chapter—this is reserved for the discussion chapter that follows.

CHAPTER FIVE — DISCUSSION

5.1 Introduction

This chapter extends the analysis of the results presented in chapter four, provides the interpretations, and discusses implications and limitations while looking at how the findings fit within extant literature. The chapter begins by recounting the problem the study sought to solve and summarises the main findings. Subsequent sections then discuss these findings following the framework of the study objectives. The chapter ends by proposing an emerging model for leader development among natural scientists, which then feeds into and provides the scaffolding for conclusions and recommendations in chapter six.

5.2 Summary of key findings

Most natural scientists are promoted into leadership positions based on technical competence, notwithstanding that technical capabilities become less a sine qua non for effectiveness as leadership responsibility increases (Stoller, 2008; Gifford and Finney, 2011; Colcleugh, 2013). Scientists need to adopt leader development approaches that can engender leadership effectiveness, yet the relationship between leader development and leadership effectiveness was yet to be studied in the context of natural scientists, particularly in developing countries like Uganda. Despite a plethora of leadership research, it is not well understood what approaches (activities, models, methods, plans, or policies) can best cultivate leadership skills among technical expert personnel or that can nurture a culture that espouses leadership development (DeRue and Myers, 2014; Saxena *et al.*, 2014; Miles and Scott, 2019).

This study set out to examine the leader development experiences of natural scientists holding leadership positions in a government agency associated with the natural sciences in Uganda. A mixed-methods case study comparing scientists and non-scientists was used. Based on the literature review, as presented in chapter two, this appears to be the first study to look into the relationship between leader development and leadership effectiveness among scientists in a developing country context. The study aimed to identify leader development approaches associated with higher levels of leadership effectiveness among leaders in natural science settings. The main questions the study sought to address was that in the context of highly technical fields such as natural sciences, what leader development approaches engender leadership effectiveness, why are they considered effective, and how do effective leaders differ from less effective leaders in their leader development experiences.

The study demonstrates a correlation between exposure to specific leader development activities and leadership effectiveness and suggests the existence of a dose-response relationship. Leaders who were highly exposed to mentorship, feedback, e-learning or formal leadership training were significantly more likely to have higher leadership effectiveness. The study also found that contextual influences such as social identity, organisational culture, subjective norms and undergraduate training have a powerful impact on leader development—affecting both leader characteristics (such as attitude and perceived behavioural control) and developmental opportunities—altogether meaningfully attenuating the appetite for leader development. On why some approaches are more effective, the study identifies specific application of approaches to leader development (such as mentorship, coaching, formal leadership training, and feedback) that make them more potent in developing leadership effectiveness.

The study also identifies, from the emerging themes, a model/framework that future researchers and practitioners could use to improve leader development. The model postulates a confluence of four dimensions—ABCD—and is consequently christened 'the ABCs of leader development'. These dimensions include A-Approaches that work, B-Beliefs that motivate, C-a context that supports and D-deliberate practice that perpetuates learning. The sections that follow discuss the meaning and implications of the findings.

5.3 Objective 1: Contextual influences on leader development

Objective one sought to identify the contextual influences on leader development unique to natural scientist leaders in Uganda. The related research question was—how do attitudes, beliefs, subjective norms, intentions and experiences of leader development among natural scientists in Uganda differ from those of non-scientist leaders? The emerging themes were presented in the results chapter and are discussed here.

5.3.1 Demographics

The results indicate that most scientist leaders in this sample are older compared to non-scientist leaders. This could explain why scientists and non-scientists were comparable in leadership effectiveness. Previous studies have indicated that age affects leadership effectiveness and leadership styles, whereby older leaders with higher legacy beliefs demonstrate empathy, collaboration and overall leadership effectiveness (Kooij *et al.*, 2011; Zacher, Rosing and Frese, 2011; Bojadziev *et al.*, 2016). Besides the legacy beliefs, a possible explanation is that such older scientist leaders are more likely to have experienced a wide range of leader development windows to enhance their effectiveness. Liu *et al.* (2020), in a study of the lifespan model of leader development, contend that there are development opportunities at each stage of life. For example, Liu *et al.* (2020) suggested that in the older group 30-60 years, challenges at work, marriage, and parenting provide a breeding ground for leadership skills. Among those above 60 years, Liu *et al.* (2020) intimated that a relational and sensitive approach to leadership is more common. With nearly half of the scientist leaders aged 50 years and above (see Table 4.2, Chapter 4, page 127), this could explain why the current study findings depict a lack of statistical difference between the leadership effectiveness of scientists and non-scientists, despite some earlier studies intimating that scientists struggle with soft skills and leadership effectiveness in general (see for example, Nick, Reinhold and Valerie, 2005; Colcleugh, 2013; Perry *et al.*, 2017; Perry, Mobley and Brubaker, 2017; Nyssa, 2019). The study findings that there were no significant differences in many of the dimensions of leadership effectiveness among scientists and non-scientists (see Table 4.10, page 176) could in part be explained by the scientist leaders being older and having transitioned from ineffective to effective leaders through leveraging a wider range of lifespan developmental experiences than younger leaders would (Murphy, 2011; Kjellström, Törnblom and Stålne, 2020; Liu *et al.*, 2020). However, this is not to mean that by simply growing older, one becomes better at leadership. Maxwell (2013) has argued that some leaders simply go through life repeating the same experience year after year without reflection to learn from it. Indeed, a further look at the current study findings reveals that after controlling for age, not all scientist leaders demonstrated high leadership effectiveness; rather, the findings intimate that higher exposure to specific leader development activities leads to higher leadership effectiveness. Not surprisingly, the specific approaches include feedback and mentorship—approaches that these study findings (see section 4.4) highlighted to be impactful when combined with reflection.

The study finding that promotion is largely due to technical expertise confirms what Perry *et al.* (2017) found and what previous studies have established (Goodall and Stoller, 2017; Geerts, Goodall and Agius, 2020). Be that as it may, because promotion is largely due to technical capabilities that take a long-time to accumulate, as was found in this study (see section 4.3), the implications are that scientist leaders are likely to be older. These study findings are in line with what Abet (2021) reported, that it takes up to 12 years in university education to qualify as a consultant specialist in the Ugandan medical field.

Furthermore, while the non-scientists have slightly more females in leadership positions, the scientists are skewed toward the male, with nearly two-thirds of scientist leaders male. The could be explained by the patriarchal, high-power distance culture inferred in the way scientist leaders lead (or 'percuss' as one respondent put it), leading to fewer females enrolling into STEM subjects in earlier life stages as intimated by one key informant (see section 4.3.6.5). A surprising finding from this study was that in all the interviews conducted, there were no notable differences between men and women in attitudes, perceived behaviour control, leader-identity or how they experience leader development amidst the context and subjective norms. It had been envisaged that given the experience of career disruptions amongst young women after they start families, the perceived behaviour control for leader development during that developmental window would be lower amongst women compared to men due to the work-family demands and unique needs of women in leadership development programmes (Ely, Ibarra and Kolb, 2011; Fitzsimmons and Callan, 2016, 2019). Moreover, from a diversity and inclusion standpoint, studies have shown that men and women bring different viewpoints to leadership (Ely, Ibarra and Kolb, 2011). Only one respondent referred to having dropped out of her PhD programme when she had three children in five years, but she quickly added that she later picked up her learning journey and went on to succeed. This could be explained by the effect of strong leader characteristics among women making such social barriers diminish their power. As Offermann *et al.* (2019) have found, women with families and those without had similar life outcomes, while those who had extended maternity experienced similar career satisfaction with those taking the standard one.

The significance of these findings is that programmes that promote STEM subjects among young women are essential. However, in addition, they could benefit more from specific encouragement of females to engage in leadership in the sciences. Even more, by promoting a less patriarchal, power-dominated approach to leadership, the conceptualisation of leadership in the sciences as more collaborative than authoritative could encourage more females to see themselves less as 'reluctant leaders'. Moreover, as seen in section 4.3.6.6, ambition and self-efficacy were found to be a strong leader characteristic that nurtures an interest in leader development—something other studies agree with (Machida and Schaubroeck, 2011; Mesterova *et al.*, 2015).

5.3.2 Attitude

The findings depicted an attitude among scientists that has hampered growth in leadership skills, similar to what Nick *et al.* (2005) found to be a barrier to adopting soft skills amongst health scientists. Yet, soft skills are an essential multiplier of the technical skills for one to be effective (Rao, 2012). Nick *et al.* (2005, p. 12) have argued that health professionals find comfort in doing the "complicated easy" tasks that require intellect, such as designing complex plans but trivialise the "simple hard" behaviours that demand courage and discipline since they depend on emotions, feelings and integrity. This attitude that belittles soft skills inadvertently gives impetus to any resistance to participation in leader development activities. In the theory of planned behaviour, Ajzen (1991) and Fishbein and Ajzen (2011) have demonstrated that one's attitude predicts the performance of a behaviour. Consequently, when scientists, especially the early-career scientists, believe that soft skills are for weaklings or that administrative roles and people management is not for people like them, they are unlikely to participate in leader development.

Moreover, the current study findings indicate that scientists were not as involved as non-scientists in leader development activities such as sports, community, religious and school and social networks across the lifespan, something that previous studies have found to immensely add to one's learning of leadership and effectiveness (Murphy and Johnson, 2011; Cullen-Lester, Maupin and Carter, 2017; Kjellström, Törnblom and Stålne, 2020; Liu *et al.*, 2020). The scientists scoring significantly lower than non-scientist on the dimension of attitude aligns with the viewpoint permeating historical literature that scientists struggle with soft skills and leadership (Sapienza, 2004; Colcleugh, 2013; National Research Council, 2015; Perry *et al.*, 2017; Perry, Mobley and Brubaker, 2017; Nyssa, 2019). For example, in a study of medical doctors in South Africa, Mdingi (2018) found that these scientists had dismissive attitudes towards leadership skills as inferior to technical skills, an element exacerbated by the lack of leadership training within the medical education curriculum. However, some studies bring to light that the attitude of technical competencies and hard skills being the only requirement for leadership in roles superintending other experts is not unique to scientists (Rao, 2012; Jain and Anjuman, 2013). For example, Irvine and Brundrett (2019) found similar attitudes among teachers and school leaders, while Martinelli and Erzikova (2017) found the same among public relations experts. The unique contribution of the current study is that it is comparative and identifies that this problem was significantly more serious (with a lower ranking on positive attitude) amongst scientists as compared to non-scientists. Indeed, the finding that the attitude of superiority among scientists makes them desire to participate in leadership only at the senior-most ranks could be preventing them from participating as leaders at lower ranks in early career, sports and extracurricular activities. According to the lifespan model of leader development (Liu *et al.*, 2020), this implies that many scientists miss out on nurturing their leadership skills through such opportunities and development windows.

The finding that fewer scientists than non-scientist reject the notion that they are already fit for leadership and therefore do not need further training in leadership could be explained by the scientists' belief that they are already leaders by virtue of their superior technical qualifications. This, in one part, aligns to a study by Goodall and Bäker (2015) where they argued that technical expertise gives the scientist *expert signalling*, an understanding of the work that juniors do and therefore enables them to manage performance better than a non-scientist or someone without such superior industry experience. However, as Goodall and Bäker (2015) themselves highlight, expert signalling is only one part of what gives an expert leader overall effectiveness—leadership capability, being the other. Therefore, it is imperative that such attitudes that conjecture that all technical experts need to succeed and deliver superior performance is superior technical qualifications be discouraged in favour of programmes that seek to improve leadership effectiveness among scientists. Requiring leadership credentials alongside technical qualifications before one is considered for promotion could be one such policy level incentive to elevate the value of leader development.

5.3.3 Beliefs

The study findings indicate that scientists overall had beliefs supportive of leader development and believed that leader development is essential for performance, notwithstanding that non-scientists appeared to have a more emphatic posture in their belief. This finding is both similar and dissimilar to other studies conducted elsewhere. It is similar in that it highlights the appreciation of leadership skills and readiness to engage in leader development, as was found among dental students in South India (Murugaboopathy *et al.*, 2020) but dissimilar as was found among medical practitioners in South Africa (Mdingi, 2018). Moreover, historical literature suggests that most scientists' beliefs are less supportive of leader development. One explanation is that leader development among scientists in Africa is a new phenomenon, while the need to improve leadership in scientific organisations started much earlier elsewhere (Nakanjako *et al.*, 2015; National Research Council, 2015). Another explanation could be the demographics of respondents to the current study. Older, more experienced scientist leaders who had risen to the senior-most levels of their organisations are expected to have reflected on the value of leadership. Moreover, the qualitative interviews showed a pattern where these senior scientist leaders did not value leadership skills in their early career and student days. Fishbein and Ajzen (2011) accentuate the effect of beliefs on an individual's intent to carry out a behaviour such as participation in leader development. While the current study confirms the same in the context of natural scientists in Uganda, further studies may need to include junior scientists in the demographics to shed more light on how supportive scientists' beliefs in leader development are.

5.3.3.1 Leadership conceptualisation

Notwithstanding that senior scientists' beliefs transformed as they grew in rank, the findings also demonstrated how the conceptualisation of leadership as an influence by authority—'percussion'—had an undesirable consequence of not seeking to learn soft skills needed for collaborative leadership such as transformational leadership styles. This view of leadership as an influence because of a superior rank is consistent with Hofstede's ascertainment of East African countries as having high power distance cultures. According to Hofstede's (2001) cultural dimensions theory, power distance plays a significant role in communication, interpersonal relations, and leadership. Hofstede has explained power distance as "the extent to which the less powerful members of organisations and institutions accept and expect that power is distributed unequally" (Hofstede, 2001, p. 98). Cultures that endorse low power distance, like the UK, expect and accept power relations that are more consultative or democratic. In contrast, cultures with a high power distance do not expect individuals with low power to challenge those above them (Hofstede, 2001; Dickson, Den Hartog and Deuling, 2003).

This finding further emphasises how the definition of leadership adopted, the implicit leadership theory and how generally leadership is conceptualised significantly affects how leadership is measured or developed—a phenomenon well-argued in extant literature (Barker, 1997; Kaagan, 1998; Day, 2000; Oyinlade, 2006; Day and Dragoni, 2015). Goodall and Stoller (2017) contend that it must be recognised that physicians, as experts, ought to be at the helm of health care organisations. Indeed, the current study corroborates that medical expertise is needed alongside leadership skills, but like Nick *et al.* (2005) recognise, it is not an either/or issue with both technical, medical expertise (complicated easy) and leadership capability (simple hard) necessary but individually insufficient to lead to leadership effectiveness. This study goes beyond what some studies into the leader development phenomenon have done—that is, looking at the leader development activities needed and their nature, structure, content and design (Bronson and Ellison, 2015; Goodall and Stoller, 2017; Lacerenza *et al.*, 2017; Geerts, Goodall and Agius, 2020)—to examine the contextual and personal characteristics that could engender or impede the learning of leadership irrespective of how well the training programmes have been designed.

5.3.3.2 Leader self-view and social identity

The current study found that scientists in general and medical doctors, in particular, have a social identity of being superior and that at the undergraduate level, social classifications and expectations of not engaging in leader development were strong, as discussed later on subjective norms. Consistent with historical literature, the study findings suggest that leader-identity, self-efficacy and social identity have a significant impact on leader development behaviour (Bandura, 1977, 1986; Ashforth and Mael, 1989; Machida and Schaubroeck, 2011; Mesterova *et al.*, 2015; Cassar, Bezzina and Buttigieg, 2017). This is likely because a leader's self-view and leader-identity influence their application to and optimisation of any leader development interventions and opportunities presented (Hannah *et al.*, 2008; Liu *et al.*, 2020). Individuals who see themselves as leaders and believe people like them can learn leadership are more likely to engage in leader development activity and make the most out of it even in the face of obstacles (Ajzen, 1991; Avolio and Hannah, 2008; Hannah *et al.*, 2008; Day, Harrison and Halpin, 2009; Liu *et al.*, 2020). Thus far, the current study is consistent with existing literature. The study adds to the literature by identifying specific contextual influences and leader characteristics that affect leader development behaviour. For example, the findings show that the scientists who persisted in engaging in leader development activities despite the engulfing non-supportive environment could be explained by the positive leader characteristics that they held—ambition, leader self-efficacy, childhood adversity and fortitude nurtured in early exposure to challenging work. This is consistent with Avolio and Hannah's (2008) findings on how developmental readiness significantly contributes to accelerating leader development.

On the other hand, the findings seem to portray a departure from what other studies have found, where a higher leader self-efficacy and learning efficacy is expected to lead to greater involvement in leader development (Avolio and Hannah, 2008; Hannah *et al.*, 2008; Murphy and Johnson, 2011; Reichard *et al.*, 2017). For instance, the current study seems to suggest a departure from what Hannah *et al.* (2008) and Hannah and Lester (2009) proposed that high leader learning efficacy (the confidence that one has that they can learn leadership) predicts stronger participation in and benefiting from leader development programmes. In the context of natural scientists in Uganda, the current study found that the majority of respondents reported having experienced high confidence that they and peers could learn leadership easily, but that this did not correspondingly lead to greater engagement in leader development activity. This is likely explained by the (mis) conceptualisation of leadership as an influence by authority—in which case, the arduous efforts to learn the "simple hard" skills (Nick, Reinhold and Valerie, 2005, p. 12) is perceived to be less important for one who already perceives that the technical qualification is sufficient to get them that influence. Additionally, as Shipman and Mumford (2011) have explained, overconfidence can be detrimental when it is about the outcome. Moreover, highly sophisticated and intellectually competent natural scientists may find frustration in learning soft skills that they previously perceived to be a walk in the park. As Nick *et al.* (2005) have surmised,

> People who have been brought up to value the 'complicated easy', and that includes many health care professionals, often dislike the simple hard…[because]..the complicated easy is more intellectually satisfying, and there is a tendency to dismiss what is simple as 'simplistic'…[and] once you have grasped the concepts of the complicated easy, you can apply them immediately. Your ease of doing so will increase with experience, but it is possible to use them well as soon as you have properly understood them. Not so with the simple hard. Implementing these takes much practice, much experience and reflection on that experience. Implementing the simple hard is as much to do with integrity as it is with intellect (Nick, Reinhold and Valerie, 2005, pp. 12–13).

5.3.4 Subjective norms

The finding that scientists experience normative behaviours right from their undergraduate levels, such as not engaging in social activities as a result of social identity and time trade-offs because of an arduous curriculum only focused on technical skills and devoid of soft skills, concurs with similar findings in the Mdingi (2018) study. Moreover, it is congruent with Hogg's (2001) theorising that engaging in prototypical behaviours is a strong motivation partly due to the attendant influence and enhancements in self-esteem and social attraction. However, the implication is that scientists miss out on opportunities to grow their leadership. As some studies show, engaging in such activities as sports, dating, early marriage or leadership in religious or social associations contributes greatly to someone's leader development (Murphy, 2011; Kniffin, Wansink and Shimizu, 2015; Martinelli and Erzikova, 2017; Liu *et al.*, 2020). As some participants in the study suggested, educators need to include leadership training in undergraduate programmes and provide experiential learning opportunities, say with cross-disciplinary team projects that involve social scientists as some in the medical field have advocated for (Nakanjako *et al.*, 2015). Organisational development practitioners in natural science institutions should lead dialogues, mentorships and provide incentives in order for early-career scientists to value the complementary nature of leadership skills to technical skills.

5.3.5 Perceived behaviour control

Building on the subjective norms discussed above, another area where scientists scored high, albeit lower than non-scientists, was on perceived behaviour control. The findings suggest that this is reinforced by attitudes, beliefs and subjective norms, whereby scientists believe that sciences are hard and complex requiring one to invest fully in that—lest they do not grow in their careers (Perry *et al.*, 2017; Perry, Mobley and Brubaker, 2017). Moreover, in Uganda, as reported by Abet (2021), the number of senior consultant specialists is so low that they are too overwhelmed to make time for learning other skills; save for the technical qualification. The result is that developing leadership skills takes a back seat. Scientists strongly believe that they can develop their leadership if they wanted to, but add that the environment makes it difficult for those who want. Leader development must, therefore, be promoted at the start of the pipeline when early-career scientists have the motivation to engage as opposed to older scientists whose legacy beliefs could have waned and who have limited time to participate (Zacher, Rosing and Frese, 2011; Coltart *et al.*, 2012; Rice *et al.*, 2020).

5.3.6 Intention

The results found that intention to engage in leader development among scientist was high even though not as high as non-scientists. Nonetheless, fewer scientists had concrete plans to undertake specific leader development in the next 90 days. The results imply that leaders might have good intentions, but other influences get in the way of actualising these intentions. One explanation is that scientist leaders are often so overwhelmed with a large span of control and overworked due to a shortage of expert staffing (Cupit *et al.*, 2019; Abet, 2021) that practical realities of work get in the way of developing leadership. This exacerbates the need to catch them early and develop leadership skills while they are still in at the start of the pipeline for technical training (Nakanjako *et al.*, 2015; Perry, Mobley and Brubaker, 2017; Mdingi, 2018; Baas, Dewhurst and Peyre, 2020; Manikkath *et al.*, 2020; Murugaboopathy *et al.*, 2020). Including leadership education in undergraduate curriculums and integrating experiential learning leadership programmes in post-graduate and early career stages is critical not only to have a paradigm shift in the way scientists appreciate leadership skills but also how they learn them. As previous research has established, learning of leadership is cumulative, and greater impact is obtained from experiential and reflective processes (Stanton and Grant, 1999; Mumford, Campion and Morgeson, 2007; Kjellström, Törnblom and Stålne, 2020).

An alternative explanation, as emerged in the qualitative interviews, is that leader characteristics such as developmental readiness, learning efficacy and discipline account for why some leaders make good on their intentions to engage in leader development while others do not (Hall, 2004; Avolio and Hannah, 2008; Hannah *et al.*, 2008; Reichard *et al.*, 2017). Once again, the powerful influence of leader characteristics and self-beliefs in enabling one to navigate contextual challenges and barriers comes into play. It might, therefore, be helpful for learning and development practitioners in natural science organisations, in light of budgetary constraints, to be selective in whom they invest in as a priority—not all popcorn will pop. For example, Avolio and Hannah (2008) have proposed that leader development interventions ought to "first focus on assessing and then building the developmental readiness of individual leaders, as well as the developmental readiness of the organisation as prerequisite steps for accelerating positive leader development" (Avolio and Hannah, 2008, p. 331).

This study findings confirm two of the leader characteristics—self-efficacy and motivation—from what Grossman and Salas (2011) put forward as trainee characteristics that determine whether learning transfer succeeds or not. The findings also highlight that the respondents, having risen to the top of their leadership careers, were atypical compared to their counterparts. This implies that deliberate practice in leader development is something not highly adopted and that leader development remains haphazard many years after scholars have pointed to the need to be intentional (Conger, 1993; Day, 2010). The findings underscore that leaders who are intentional, motivated and demonstrate deliberate practice are more likely to engage in leader development and possibly produce stronger learning transfer. The implication is that at the centre of congruent factors that make any leader development efforts work, deliberate practice and design must be adopted (Baas, Dewhurst and Peyre, 2020; Kjellström, Törnblom and Stålne, 2020).

5.3.7 Contextual influences

Findings showed that contextual influences such as organisational culture, societal expectations, the structure and nature of undergraduate training, and resource constraints, impact leader development. Previous research has demonstrated that not including leadership training in medical and engineering education curriculums reduces the value these scientists attach to leadership (Colcleugh, 2013; Nakanjako *et al.*, 2015; Perry *et al.*, 2017; Mdingi, 2018). No such previous studies have been reported in the area of agricultural sciences. By integrating three natural science disciplines, this study shows the impact of lack of leadership training in STEM curriculums in general. A unique contribution of this study is the demonstration that the lack of leadership skills and soft-skills training at the undergraduate level makes scientists worse off than their non-scientist counterparts who have soft-skills training in their programmes. Moreover, the non-scientists undergraduate programmes are structured in such a way that students get to socialise, network and engage in sporting activities—thereby maximising the developmental window that a university process is for leader development.

While integrating leadership training in undergraduate curriculums for engineers, doctors and agriculturalists would improve leader development and leadership effectiveness, perhaps the greatest strategy to address the contextual gaps in leader development among scientists is to structure the learning programmes for these scientists to include inter-disciplinary collaborative projects, and experiential learning that makes them engage with the wider community where they are expected to apply their technical knowledge after graduation. Even more, to provide time for and encourage scientists to engage in social activities such as sports. Participants in the current study highlighted how it was extremely difficult to engage in sports, student leadership, or other community activities at the time of their undergraduate training because, to begin with, such is counter-cultural for scientists as per subjective norms and societal expectations. Secondly, the structure of medical, engineering or agricultural training is such that no time allowance is made for extracurricular activities. Study participants recounted their experience in experiments, ward rounds, and group discussions organised after class that may be considered optional but missing of which, one would be disadvantaged academically. This is important because previous studies have found that engaging in social activities and sports has life-long benefits in improving one’s performance in leadership and other areas of life (Murphy, 2011; Kniffin, Wansink and Shimizu, 2015; Cullen-Lester, Maupin and Carter, 2017; Liu *et al.*, 2020). For example, in a longitudinal study of the life-long impact of participation in sports at high school, Kniffin *et al.* (2015) have demonstrated that those who participated in university level sports 60-years earlier exhibited significantly more leadership than those that did not.

Furthermore, previous research suggests that leader development is a multi-faceted process whose effectiveness is not limited to the content, structure and design of the programme but is also affected by the broader context, timing and specifically the leader characteristics such as leader identity and leader self-efficacy (Mumford, Marks, *et al.*, 2000; Day and Harrison, 2007; Mumford, Campion and Morgeson, 2007; Hannah *et al.*, 2008; Day, Harrison and Halpin, 2009; Harms, Spain and Hannah, 2011; Johnson *et al.*, 2018). On the organisational side, extant literature suggests that there are subjective norms and structural processes peculiar to natural scientists like medical doctors and engineers that might impede nurturing of leadership skills (Brazier, 2005; Colcleugh, 2013). For example, the process of developing expertise in technical fields such as medicine takes years. Because of the premium attached to excellence in technical skills, little room is left for natural scientists to engage in developing social skills and other leadership competencies (Guthrie, 1999; Farr and Brazil, 2009; Stoller, 2009; Mazzoccoli and Wolf, 2016; Perry *et al.*, 2017; Geerts, Goodall and Agius, 2020) such as "strategy, communication, persuasion, motivation, and myriad people skills" (Perry *et al.*, 2017, p. 3).

It has been a long-held view in the literature that context impacts the leader development and leadership effectiveness (Day, 2000; Dickson, Den Hartog and Deuling, 2003; Brazier, 2005; Ayman and Lauritsen, 2018; Oc, 2018; Ng'weno, 2020). However, researchers have approached context from a multiplicity of perspectives (such as policy, politics, learning transfer, socio-economic factors, national or industry culture) sometimes with inconsistent findings (Cheng and Hampson, 2008; Blume *et al.*, 2010; Grossman and Salas, 2011; Pollock, Jefferson and Wick, 2015). This makes it difficult for organisations seeking to address elements within their context to enhance leader and leadership development to isolate what is critical from what is mundane (Grossman and Salas, 2011).

The current study brings additional clarity to the contextual factors that critically affect leader development among natural scientists in a developing country setting. For example, of all the factors identified as important in Grossman and Salas's (2011) model of the learning transfer process, the work environment weighted extensively more than trainee characteristics or training design. Addressing work environment policies is, therefore, important because the current study findings identified that the practice of promoting scientists into leadership mainly on the basis of technical competence is ubiquitous. Referred to as the Peter principle, the phenomenon describes how organisational HR systems and practices promote the best performing technical personnel to the next level of management, with the responsibility to oversee their fellow technical personnel albeit taking such a person away from their area of competence into a leadership role for which they are less competent (Benson, Li and Shue, 2018; Ghinea, Cantaragiu and Ghinea, 2019).

This study findings demonstrate that (a) excessive workloads, (b) the organisation's policy not to require leadership qualifications as a prerequisite for promotion into leadership positions, (c) the lack of succession planning leading to promotion into incompetence, (d) the lack of an institutionalised culture that welcomes feedback and reflection, and (e) a work environment that does not support or hold trainees accountable to perform new behaviours after training, were common contextual factors impeding leader development effectiveness. The results imply that excessive workloads make it difficult for scientists to make time for socialising, networking and even attend training on leadership. This study brings light to the implications of a large workload and span of control, as was found in a study among nurse managers (Cupit *et al.*, 2019). The results also indicate that organisations employing scientists can create an environment that nurtures an appetite for leader development by benchmarking their non-scientist counterparts that have instituted strategies such as a policy requiring formal training for senior or supervisory roles. Other areas to benchmark might include a culture of feedback and after-action reviews where leaders are open to criticism; intentionality in leadership succession planning where acting in leadership roles is a deliberate practice to grow the next level of leaders; and where training transfer is improved through clear accountability, line-manager coaching and mentorship support (Day, 2010; Seifert and Yukl, 2010; Ghinea, Cantaragiu and Ghinea, 2019; Kjellström, Törnblom and Stålne, 2020).

5.4 Objective 2: Impactfulness of leader development approaches

The second study objective sought to identify the leader development approaches considered more effective for natural scientists. Accordingly, the research question was—what leader development approaches are considered more effective than others within the context of natural scientist leadership and why? On the question of which leader development approaches are considered more effective among scientists, the study identified mentorship, experiential learning, feedback, acting in a leadership role, self-awareness, and coaching. These were rated highest by scientists, and each significantly higher by non-scientists (Table 4.9, page 159).

Participants in the science FGDs highlighted that they might have perceived an approach (for example, coaching) to be effective based on what they have heard. They may even have desired to engage in it, but that availability, accessibility and other constraints could have made it more difficult for them to experience it. This might also explain why scientists elected to score approaches like coaching as highly impactful while also scoring them as the least exposed areas. A critique may argue, then, that the relative ranking of the impactfulness of an approach by the not so exposed scientists might be misleading and appears contradictory. While that may appear so, it might not be, for two reasons. First, most scientist respondents were older and more senior in leadership and consequently must have had some exposure to these approaches. Secondly, the apparent contradiction is valid only if one considers the quantitative results in isolation and applies a post-positivist lens to interpretation. The study, however, used a mixed-methods pragmatist approach that combines both the post-positivist and constructionist lens. By looking at the explanations from the scientists themselves, the study implies that, based on their own experiences, and long careers, the six leader development approaches scoring a mean above 4.0 are reliably the most impactful for their context.

The cut off mean for effectiveness was set at 4.0 to avoid the effects of extreme response bias, considering that most respondents scored on the upper end of the scale. The finding that nearly all approaches are relevant and impactful for non-scientists is not surprising. Previous studies have alluded to the need for utilising all available developmental opportunities, formal and informal, for leader development (Day, Harrison and Halpin, 2009; Manuti *et al.*, 2015; Turner *et al.*, 2018; Kjellström, Törnblom and Stålne, 2020; Liu *et al.*, 2020). Even historical literature traced back to Dewey (1938) and Lewin (1942, 1946) conceptualised experiential learning in terms of any experience, even one that an individual can make up, through a constructionist lens, as was discussed in chapter two. However, with budgetary constraints, time constraints and a myriad of challenges that the context brings to natural scientists, it is imperative that policy elites, educators, learning and development professionals and scientist leaders narrow down the list to the most impactful for their context, as has been advocated for by some scholars (Salas *et al.*, 2012). Even then, the goal is not to identify one approach but a set of highly impactful approaches for the specific context, as some studies have found that using at least two or multiple methods facilitates development, learning transfer and effectiveness (Lacerenza *et al.*, 2017, 2018). The contribution this study makes is to find a small set of impactful approaches that are truly context-appropriate.

On the question of why are these six approaches effective, the findings from the qualitative data appear instructive. Respondents in the study suggested that experiential learning and acting in a leadership role, when coupled with reflection, is very effective because it enables scientists to learn on the job and not have to step away as formal training, networking or benchmarking would do. However, as this study findings show, it is an approach that is rife with scientists muddling through and making many people management errors. Nonetheless, extant literature aligns with this experience, and some scholars have argued that sometimes mistakes must be made at the expense of short-term business outcomes in order to develop future leaders for strategic reasons (Day, 2000; Torbeck, Rozycki and Dunnington, 2018; Yu *et al.*, 2018). This should not be considered an open pass for scientists to continue making leadership errors, but a warning that approaches such as acting in a leadership role and experiential learning are prone to costly mistakes and need to be integrated with other approaches such as mentorship, feedback and formal leadership training.

When intentionally scheduled, the reflective aspect of experiential learning also gives it power, particularly when integrated with feedback and support (Schon and DeSanctis, 1986; Conger and Benjamin, 1999; Conger and Toegel, 2002; Day *et al.*, 2014). The study finding is consistent with the tenets of action learning where previous research has advocated reflection as a strong practice in improving the learning from experience (Baird, Holland and Deacon, 1999; Kriflik and Kriflik, 2006; Leonard and Lang, 2010; Masango-Muzindutsi *et al.*, 2018). For example, in a study of early-career scientists in the U.S., Banerjee (2013) found that collaborative developmental action inquiry could change attitudes, beliefs, knowledge and behaviours and improved collaboration and interpersonal relationships amongst these scientists. Furthermore, the study aligns with what Yip and Wilson (2010) and other scholars who have argued that the most impactful approaches are those that leverage experiential learning's power of challenging assignments (McCall, 2004; McCall and Hollenbeck, 2008; Mccauley *et al.*, 2013; Hezlett, 2016).

In line with previous studies, coaching was considered impactful when a strong relationship is forged between the coach and coachee and when it is integrated with feedback, mentorship and support (Ely *et al.*, 2010; De Haan *et al.*, 2013; Korotov, 2017; Albizu *et al.*, 2019). What is new that the study adds is that coaching is effective because of the psychological safety it gives technically senior leaders who may be novices in leadership, but given the hierarchical nature of leadership and the power-distance dynamic, do not want to appear learning together in the same space as their juniors. This study also provides reasons why the practice is not well adopted despite its perceived effectiveness. The study highlights that the coaching industry is in a nascent stage, not well regulated and has very few professionally trained coaches. Given the apparent impactfulness of coaching, training line-managers in the discipline of coaching and deploying them as coach-managers would fill the gap in the meantime.

The reasons why formal leadership training, mentorship, feedback and acting in a role are effective are stated in chapter four. In line with extant literature, formal leadership training was considered effective when aligned to organisational outcomes; real-life problems and case studies are used; and when there is a strong learning transfer environment (Raelin, 2011; Pollock, Jefferson and Wick, 2015). However, while the study identifies formal training as an effective approach, it also calls attention to the fact that in light of strong negative organisational culture norms where the motivation for training is primarily for financial reward, leader characteristics must be considered before enlisting the most deserving of trainees (Grossman and Salas, 2011; Lacerenza *et al.*, 2017; Kjellström, Törnblom and Stålne, 2020).

Mentorship was considered effective because it leverages the power of feedback and real-time support from mentors who are accessible within the organisation. Therefore, older scientists need to make time to groom the next set of leaders as part of their legacy considerations and succession planning. Some studies have also argued that mentors need support to be effective (Gonçalves and Bellodi, 2012). The current study found that mentors in the scientific world also need support and training, as mostly, while they might be the ideal role model from a technical competence perspective, many were reported not to have had good examples to learn leadership from themselves. As the implicit leadership theory suggests, such mentors will only pass on the own view of leadership (Schyns *et al.*, 2011; Epitropaki *et al.*, 2013; Harrison, 2018). Moreover, most scientists experienced only the informal mentoring process, yet extant literature suggests that a combination of formal and informal mentoring gives the optimal mix (Hong and Idris, 2015; Nakanjako *et al.*, 2015; Clardy, 2018).

The study findings on what makes feedback work are in consensus with established norms in the literature (Conger and Toegel, 2002; DeShon *et al.*, 2004; Sparr and Sonnentag, 2008). For example, the current study suggests that feedback should not be tied to performance appraisals as this makes it even more challenging for a context like Uganda, where the culture of giving and receiving critical feedback for improvement is in its infancy. Several participants commented that while a manager could be frustrated with someone's performance, they continue to give rosy feedback in appraisals because the appraisal process is formal and enters the official record. In which case, poorly performing individuals could lose their jobs. Regular, specific feedback is necessary for one's growth; however, the institutional culture must be nurtured for leaders to welcome the feedback (Seifert and Yukl, 2010). The use of 360-degree feedback was novel for many study participants, and training on how to effectively use it is recommended (Day, 2000). Whereas few leaders have used 360-degree feedback, there was no evidence of managers and direct reports discussing the feedback—something that previous literature suggests enhances the effectiveness of feedback as a leader development approach (Day, 2000).

5.5 Objective 3: Leader development approaches and leadership effectiveness

The third study objective sought to assess the level of exposure to leader development approaches and its relationship with perceived leadership effectiveness among natural scientists. Accordingly, the research question was—how does the degree of exposure to particular leader development approaches relate to perceived leadership effectiveness among natural scientists?

5.5.1 Leadership effectiveness

The results presented in chapter four show that scientists and non-scientists were comparable in their perceived levels of effectiveness. Except for the significant difference in the dimension of ethics and accountability, which was attributed to the difference in organisational cultures and systems, all other dimensions of leadership effectiveness are comparable. This is a surprising finding considering that existing literature has inferred that scientists, in part due to their positivist training, lack of leadership training as part of their technical curriculums and a disdain for politics of influence, struggle with leadership skills in comparison to their non-scientist counterparts (National Research Council, 2015; Perry *et al.*, 2017; Perry, Mobley and Brubaker, 2017; Torbeck, Rozycki and Dunnington, 2018; Nyssa, 2019; Wefes, 2020). One explanation could be that since this was a self-report assessment, and given the response bias often associated with self-report evaluations (Moorman and Podsakoff, 1992; Donaldson and Grant-Vallone, 2002), scientists might have perceived themselves more effective than they actually are. Moreover, as Dunning (2011) has explained, those unaware of what good leadership looks like are likely to overestimate possessing it because of the unknown unknowns.

The other, more plausible explanation is that, indeed, as the qualitative findings showed, scientist leaders are not always effective in leadership in their early career. However, as they grow older, due to adult development, exposure to multiple leader developmental windows and exposure to mentorship, feedback, formal training, experiential learning, and challenges at work, they get better and effective.

The demographic data in Table 4.2 (page 127) showed that the scientists participating in the study were mostly above 50 years and more educated. The cumulative nature of leadership development enables older and senior leaders to demonstrate higher leadership effectiveness (Mumford, Campion and Morgeson, 2007; Perry, Mobley and Brubaker, 2017). Moreover, some recent studies have found that these developmental activities, indeed, improve ones' leadership effectiveness (Lacerenza *et al.*, 2017; Geerts, Goodall and Agius, 2020).

The results imply that the skills scientists need to succeed at leadership may be similar to those of their non-scientist counterparts, and therefore, scientists could benefit from training programmes and leader development opportunities that integrate cross-functional, cross-disciplinary and multi-profession attendees and case studies. The sharing of scenarios, experiences, challenges and best practices across scientists and non-scientists may be beneficial. Additionally, the results imply that most leaders surveyed have a strong view of their own effectiveness as all mean scores were above 4.00, signifying either validly enhanced leadership effectiveness or the effects of social desirability bias and extreme response bias. Future research should deploy a multi-rater approach such as the 360-degree leadership assessment to more effectively measure leadership effectiveness.

5.5.2 Association between leader development and leadership effectiveness

The finding that scientists and non-scientists were similarly exposed to various leader development approaches, save for experiential learning, could be explained by the same argument on demographics discussed above. The study finding that experiential learning is more prevalent among scientists agrees with a recent study by Geerts *et al.* (2020). They found that action-learning and videotaped simulations integrated with peer and expert feedback were amongst the most effective interventions in developing leadership skills among physicians. The leader development interventions that this study found to be significantly associated with higher leadership effectiveness include mentorship, feedback, e-learning and formal leadership training. The finding on mentorship and multi-source feedback is consistent with Geerts's *et al.* (2020) findings. Geerts *et al.* (2020) also found that when training workshops are done interactively, they are effective, something corroborated by Lacerenza *et al.* (2017). E-learning has not been identified in previous studies as highly impactful, although some have argued that it is popular in organisations (SHRM, NOCA, and EFMD, 2016). The popularity could be explained by the flexibility the approach offers leaders, which is also likely to increase given the changing dynamic of learning due to COVID-19 (Hew, 2016; Schaefer *et al.*, 2019; Bao, 2020; Chiodini, 2020). However, as this study findings highlight, frequent exposure to e-learning is necessary to register high leadership effectiveness, and occasional engagement with e-learning programmes might not suffice. Moreover, the approach can be made interactive, and if integrated with other approaches like feedback, mentorship and coaching, could greatly benefit leaders (Yu and Yu, 2010; Hew, 2016; Jong, Verstegen and Könings, 2018; Schaefer *et al.*, 2019; Goshtasbpour, Swinnerton and Morris, 2020).

A surprising result was that high exposure to coaching or self-awareness was not significantly associated with higher leadership effectiveness, yet previous studies have highlighted the import of coaching, self-awareness and emotional intelligence on leadership effectiveness (Berg and Karlsen, 2012; Ladegard and Gjerde, 2014; Van Oosten, 2014; Korotov, 2017; Rubens *et al.*, 2018; Albizu *et al.*, 2019; Frick, 2019; Taylor, Passarelli and Van Oosten, 2019). This could be explained by the fact that, to begin with, exposure to these interventions was quite low in both groups, as seen in Table 4.21 (page 187). Another plausible explanation is that given the limited access to professional coaches, those who participated in coaching could have worked with ineffective coaches or had poor relationships with their coaches—something that previous research suggests immensely diminishes coaching effectiveness (Stewart *et al.*, 2008; Grant, Curtayne and Burton, 2009; De Haan *et al.*, 2013).

5.6 Objective 4: Approaches that engender leadership effectiveness

The fourth study objective sought to explore the leader development approaches that are likely to lead to leader effectiveness among natural scientists. Accordingly, the research question was—what leader development approaches and practices are associated with higher leadership effectiveness among natural scientists? In terms of interventions, as discussed in 5.4 and 5.5 above, the study recommends mentorship, feedback, formal leadership training, experiential learning, acting in a leadership role, and coaching. This is partly because mentorship, feedback, and formal leadership training were significantly associated with higher leadership effectiveness, as seen in Table 4.32 (page 194).

While experiential learning was not significantly associated with high leadership effectiveness, it is recommended because it is the only intervention to which scientists were exposed significantly higher than non-scientists. Even more, previous studies have likewise demonstrated that it is highly impactful. Some scholars have, for example, contended that if one were to reduce the learning of leadership only to one activity, the most impactful would be experiential learning (McCall, 2004; McCall and Hollenbeck, 2008; Yip and Wilson, 2010). Moreover, as seen in Table 4.21 (page 187), it ranks highest as a primary activity for leader development amongst scientists. For similar reasons, acting in a leadership role is included, particularly because it ranks second highest as a primary activity for development and because, like experiential learning, when combined with reflection and feedback, its knack for bringing challenging developmental experiences to the leader is high. Challenging work has been recognised as a source of impactful leader development both from the qualitative interviews in this study and in previous research (Yip and Wilson, 2010; Mccauley *et al.*, 2013; Kjellström, Törnblom and Stålne, 2020). Moreover, as seen in Table 4.9 (page 159), scientists perceive the approach to be among the highly effective ones.

While coaching neither demonstrated a significant dose-response relationship with higher leadership effectiveness nor were scientists highly exposed to the approach, it is recommended on the basis that coaching enhances psychological safety, as this study qualitative findings demonstrated. Moreover, as seen in Table 4.9 (page 159), the method was regarded as highly effective and impactful by the scientist leaders in the study.

The study demonstrated that exposure to e-learning was significantly associated with higher leadership effectiveness. However, as discussed in section 5.5 above, although previous research has highlighted its potential and popularity, its effectiveness is in doubt. Moreover, this study's qualitative findings highlighted that e-learning has not been as impactful in nurturing leadership skills. For these reasons, it is not recommended as a priority activity that engenders leadership effectiveness. Other approaches that are not recommended on the basis of the findings shown in this study include self-directed learning, self-awareness, and networking. This is not to say that such activities are irrelevant, but rather to accentuate what works better in the context of natural scientists in a developing country setting.

5.6.1 Approaches that engender leadership effectiveness

The preceding section outlined six leader development interventions that engender leadership effectiveness. However, this discussion underscored why they are effective and argued that specific applications (for example, integrating coaching with feedback for coaching to work; linking formal training with post-training transfer support; integrating mentorship for training to be effective and creating a culture that welcomes feedback for feedback to be used effectively), are necessary to engender leadership effectiveness as an outcome of leader development. Therefore, an approach that engenders leadership effectiveness is one that integrates what enhances effectiveness but also aligns with the contextual factors that influence learning and the leader characteristics. This suggests that deploying the intervention is insufficient in driving positive outcomes. Previous research has stressed the importance of the context, the post-intervention transfer period and trainee characteristics (Grossman and Salas, 2011; Pollock, Jefferson and Wick, 2015; Kjellström, Törnblom and Stålne, 2020).

In section 1.11.3, a key term—*approach*—was described to represent practices, experiences, activities and strategies that organisations or individuals deploy purportedly to learn leadership skills effectively. Approaches may include activities, policies, norms, leadership conceptualisations, and the process of clarifying attributes desired in leaders—the target of the development itself (Kaagan, 1998; Mumford, Marks, *et al.*, 2000; Liu *et al.*, 2020). Then, what emerges is that for an approach to work, it must link and align to other contextual influences in a triangle of constructs that are subsequently labelled—Approach, Beliefs, and Context—the ABCs of leader development. The current study has also highlighted that deliberate practice is essential in making the approach work. Qualitative findings in the study stressed how leadership for many was haphazard, but that intentionality was the key to make the most of any intervention. Therefore, deliberate practice is also added to the triangle inferred above as an integrating step in making approaches effective. The triangle shape was chosen for its ability to depict the interplay and interdependence of the four dimensions. The ABC model is described below.

5.7 Objective 5: The ABC model of leader development

The fifth study objective sought to develop a model appropriate for leader development among natural scientists. Accordingly, the research question was—what model can explain effective leader development among natural scientists?

Using the method of inductive reasoning (Heit, 2000; Thomas, 2006) where themes, and patterns in the study qualitative findings were triangulated with the quantitative results and the literature review, the ABC model of leader development emerged. The ABC model expands on frameworks put forward in previous research (Grossman and Salas, 2011; Pollock, Jefferson and Wick, 2015; Geerts, Goodall and Agius, 2020; Kjellström, Törnblom and Stålne, 2020; Liu *et al.*, 2020) first, by simplifying the needed interventions to the minimum list for effectiveness (Lacerenza *et al.*, 2017; Geerts, Goodall and Agius, 2020) and secondly, by integrating the contextual factors that the study identified as giving the interventions power to succeed or fail. It is believed that this model will be a helpful guide to practitioners and researchers who seek to analyse existing programmes for effectiveness or when designing new ones.

As has been found in previous studies on learning transfer, it is critical to address all the input factors at the trainee level, design level and environmental level (Blume *et al.*, 2010; Grossman and Salas, 2011). The confluence of the factors concerning the approach, beliefs, and context—all glued together by deliberate design and practice, engenders leadership effectiveness as an outcome. The emerging model is proposed here as the ABCs of leader development among natural scientists. The mnemonic ABCs has been used to ease memory, signal ease of application and simplify an often complex challenge that practitioners face when sorting through a maze of parameters that researchers put forward in frameworks to guide leader development. For example, Kjellström *et al.* (2020) and Geerts *et al.* (2020) have argued that while many lists of activities practitioners could use exist, they offer little practical guidance to leaders and seem to have been designed with only researchers in mind. While proposing their dialogue map, Kjellström *et al.* (2020) have recommended that “Future research is needed on how the methods can be combined to catalyse development, which methods and combinations are most effective for what kind of development, and how to evaluate this effectiveness" (Kjellström, Törnblom and Stålne, 2020, p. 18). The ABC model signals simplicity, foundationalism and all-inclusiveness of the methods and how they can be combined to engender leadership effectiveness among natural scientists. The model can be used in the analysis of existing programmes to assess effectiveness or in the analysis for the design of proposed programmes to engender effectiveness. The model constituent parts are described below.

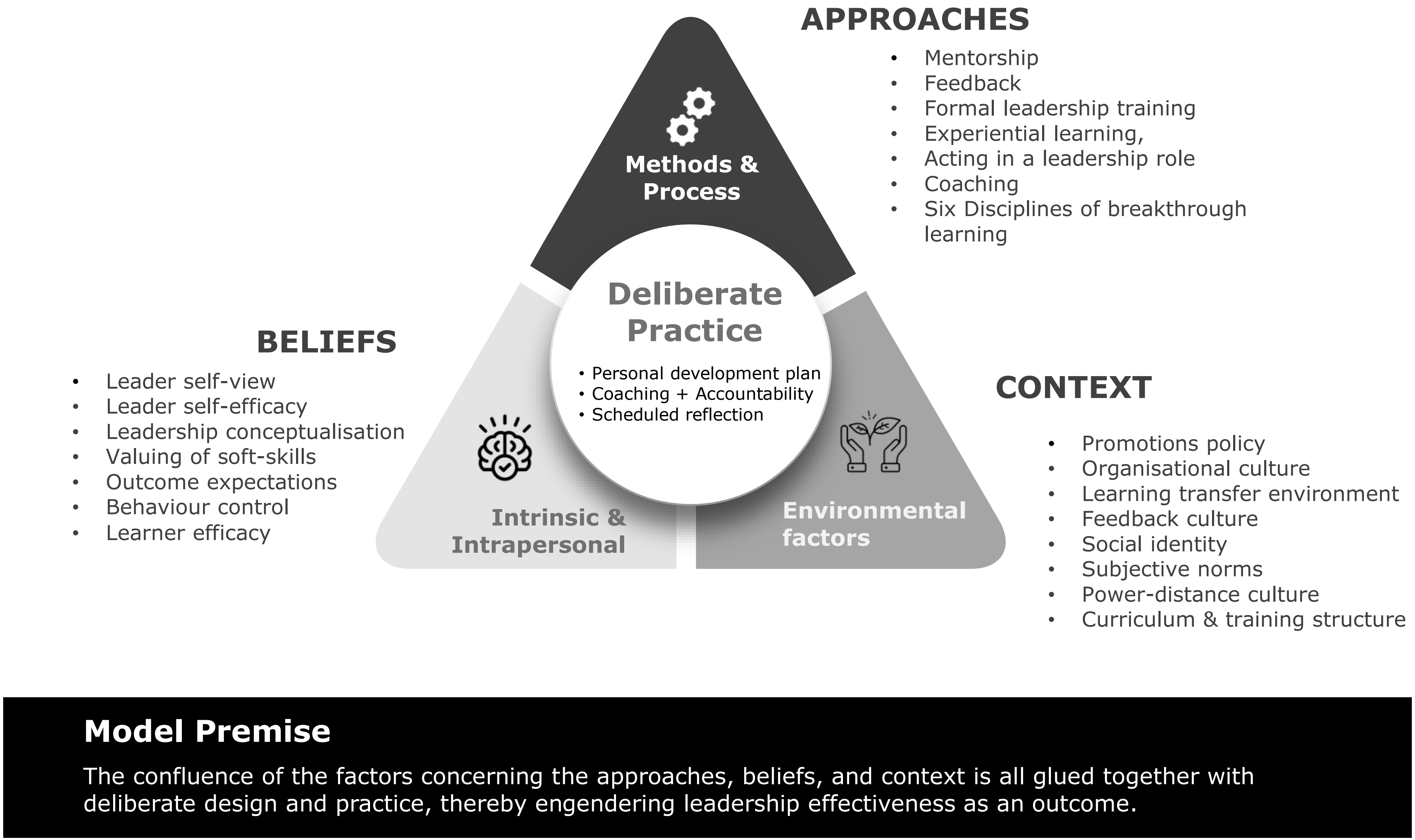

Figure 5.1 The ABC Model of leader development among natural scientists. *Source: Own*

Approach

Approach starts with the interventions or methods but does not end there. It includes scrutinising the organisational culture and transfer environment, the development needs of the leader(s) being considered and aligning both the methods, needs and context. For example, scrutinising the organisational culture and transfer environment might bring to light problems with how feedback is given or received, wherefore the deployment of a leader development programme that integrates feedback (for instance, if it uses stakeholder-centred coaching) would be preceded by training on feedback. Additionally, examining the leader characteristics of the prospective learners would involve selecting only the deserving leaders to attend leader development programmes. Deserving, for example, might include those lined up for succession as part of building the leadership pipeline but can also include leaders exhibiting developmental readiness, self-efficacy, learning efficacy and strong motivation. This process of designing the right approach that leads to breakthrough learning—referred to as the six disciplines or 6Ds—has been well described elsewhere (Pollock, Jefferson and Wick, 2015). Pollock *et al.* (2015) have suggested the following disciplines of breakthrough learning. While they were developed for training and development, or instructional design in general, they apply to all the six methods/approaches identified in the ABC model.

The six Ds include:

- **D1—Define business outcomes**—training and development for its sake is ineffective, even if learning objectives are clearly defined. The impact that training, coaching or mentorship will have on the organisation or team performance, and therefore the specific organisational outcome needs to be identified and explicitly highlighted both for accountability purposes and to ensure that the intervention is designed to fit that purpose.
- **D2—Design the complete experience**—to enhance effectiveness, the way the approach is designed must use the lens of a process, not an event. It involves examining what learners need before they start the developmental activity, motivating their engagement with it and clarifying expectations during and after the training, mentorship or coaching. The learning transfer period must be considered a critical part of the method itself.
- **D3—Deliver for application**—involves putting the performance goal and the skills needed to behave differently at the centre of the training or development. If coaching or mentorship, how it is done (for example, how often and with what tools and models) and who does it, become explicit decisions driven by what must happen for the leader being supported to behave differently. As Pollock *et al.* (2015) have said, "It includes the application of instructional design principles such as spaced learning, scaffolding, active engagement, preparation,

reflection, elaborative rehearsal, and practice with feedback” (Pollock, Jefferson and Wick, 2015, p. 26).

- **D4—Drive learning transfer**—Learning transfer is a critical part of making training and development work. This involves planning the post-intervention period to align with on-the-job experiences, line-manager support, reflection, and all manner of scaffolding needed to ensure that deliberate practice of newly learned skills remains a priority.
- **D5—Deploy performance support**—While deploying an intervention, ensuring the person has the support to try new behaviours is essential during and after the intervention. In this step, coaching might be integrated with another intervention to help the leader move from new knowledge to actualising the skills.
- **D6—Document results**—this process requires that the process and outcomes are documented for review purposes. This review then informs what aspects of the approach worked well and which ones need adjustment. As Dewey (1938) advocated, every learning experience is different and ought to be recognised that way. Through documentation, a coach or mentor supporting leaders A and B might learn different things about what made the approach work well for leader A than for leader B and adjust accordingly. Without documenting the content, context, and process of the intervention, the nuances of what makes it more effective in proceeding iterations become difficult to recognise.

Beliefs

This dimension of the model is about the individual leader’s attitudes and beliefs pertaining to leadership, leader development methods/approaches and the outcome expectations—what they perceive to be in it for them in case they undertook the arduous journey of skills development. It encompasses all the intrinsic motivations and intrapersonal characteristics that facilitate or impede participation in leader development. Historical literature has established consensus that beliefs and attitudes affect the intention to perform a behaviour or carrying it out (Bandura, 1986; Ajzen, 1991; Machida and Schaubroeck, 2011).

Sections 4.3.1 through 4.3.6 revealed the attitudes and beliefs that natural scientists hold and how they affect leader development. For example, if the value of soft skills and the importance attached to leadership skills is not primal in the leader’s mind, efforts must be made to transform the mindset; otherwise, whatever approach or combination thereof may come to nought. Strategies to improve attitudes may include sharing testimonials and case studies of peers that have succeeded in demonstrating a behaviour and running communication and promotional campaigns to sell the value of leadership skills (Bandura, 1971; Mahajan, Muller and Srivastava, 1990; Cullen-Lester, Maupin and Carter, 2017). Another aspect of belief that affects the effectiveness of an approach was the leader’s self-view and leader self-efficacy. Previous research has underscored how self-efficacy and leader self-view affect engaging and learning leadership skills (Hannah *et al.*, 2008; Machida and Schaubroeck, 2011; Mesterova *et al.*, 2015; Reichard *et al.*, 2017; Rubens *et al.*, 2018). The current study identified how some scientists could not engage in leadership activities in their high school, university or early-career days because they believed that leadership was not for them. Describing themselves as reluctant leaders, such an attitude attenuated their interest in leadership. To address such attitudes, practitioners and leaders seeking to grow can look to examples of role models in leadership and encourage reluctant leaders to appreciate the role that leadership plays in improving performance or nurturing a better environment for them to practice their science (Colcleugh, 2013; National Research Council, 2015; Irby *et al.*, 2017; Mumford *et al.*, 2017).

Other beliefs include learner efficacy—the belief that one can learn leadership. The current study identified beliefs to the effect that leadership and soft skills, in general, are easy to learn and can be 'microwaved' into being by those who are the intellectual geniuses that scientists perceive themselves to be. This overconfidence makes leaders not put in the effort or get frustrated once they attempt what was perceived as easy that turned out to be hard (Nick, Reinhold and Valerie, 2005). Conversely, leaders who do not believe that they can learn leadership—that it is too complex—turning their intention to learn into actual leader development behaviour will be difficult. Identifying where the leaders signed up for an intervention lie is the first step in designing strategies to enhance their perceptions on the ability to learn leadership. Finally, how leadership is conceptualised was found as a 'Belief' factor that affects the appetite for leader development. The expert leadership theory maintains that expert leaders, through technical authority, can signal credibility and project their leadership. While this expert power and influence is necessary, Barnes and Rennie (2021) have found that it nurtures dominance, authoritarianism and hierarchical leadership leading to leaders overestimating their leadership capacity. The findings in the current study are consistent with Barnes and Rennie's (2021) observation and Goodall's (2016) theory of expert leadership. Leaders who perceive that they can use their rank and authority to achieve performance goals will not be incentivised to engage in leader development activities premised on the idea that influence, persuasion and collaborative, empathetic leadership is more effective.

Context

Context is about the environment in which leadership and leader development is practised. It is akin to the architecture dimension in DeRue and Myers (2014, p. 845) PREPARE framework discussed in chapter two, Table 2.1 (page 48) as the "features of the organisational context (e.g., practices, processes, climate)," that advance and imbue leader development. It also represents Ajzen's (1991) subjective norms and how they influence behaviour adoption. Particularly for natural scientists, previous research has suggested that the industry, community of practice, subjective norms and societal expectations create a unique context (Collins-Nakai, 2006; Blumenthal *et al.*, 2012; Colcleugh, 2013; Perry *et al.*, 2017; Dias, Mathew Joseph and Michael, 2019; Miles and Scott, 2019). The study findings are concomitant with this historical literature on context as presented in section 4.3.6 and extensively discussed in section 5.3.7.

Specifically, the study established that leader development could be enhanced when the organisational systems, structures and culture are conducive for incentivising engagement in leader development. This can be achieved through managing scientists' workloads to allow time for reflection, social activity and participation in formal or structured leader development programmes. Additionally, the organisation can institute a policy that promotes leader development as a prerequisite for career growth, create a culture welcoming of feedback, and establish accountability and support scaffolding mechanisms that enhance the transfer environment—enabling people to practice newly acquired skills. Furthermore, undergraduate programmes can be designed to include leadership content in the curriculum and delivered in such a manner that they feature collaborative projects and social activities. Mindset change campaigns can be instituted to address the social identity of superiority and the power-distance culture, which combine to bring a climate of irreverence for soft skills.

Deliberate practice

Section 2.6.3 discussed the importance of deliberate practice to leader development. Historical literature has emphasised the need for intentionality and deliberate efforts to schedule reflection, discuss and make meaning of feedback, and practice new leadership behaviours (Conger and Toegel, 2002; DeRue and Wellman, 2009; Fredericks, 2009; Day, 2010; Hughes, Ginnett and Curphy, 2015; Liu *et al.*, 2020). Existing literature warns that approaching leader development in a haphazard fashion, though common, has led to wasted efforts and resources, as well designed training and development programmes end up not producing the anticipated outcomes (Burgoyne, Hirsh and Williams, 2004; Backus *et al.*, 2010; Grint, 2011; Lacerenza *et al.*, 2017). McCall and Hollenbeck (2008) contend that expertise is learned through the intentional, intensive effort for a minimum of 10 years, while Liu *et al.* (2020, p. 11) concur that growth in leadership effectiveness comes from "deliberately practising and strengthening skills learned, and applying them to real leadership contexts, all facilitated through feedback from others" (Day, 2010; Maxwell, 2013). Nonetheless, deliberate practise takes effort. While the alternative to deliberate practice might seem acceptable for those who may not prioritise leadership skills—a phenomenon common among scientists—some authors warn of an exercise in futility if intentionality is discarded. "Without intentional support, informal learning can be unruly and therefore costly. Unconsciously, incompetent people often help others become the same" (Gottfredson and Mosher, 2011, p. 11).

Pollock *et al.* (2015) contend that while incidental learning is powerful, structured programmes are essential to ensure consistency, quality, efficiency and awareness. For example, leaders might not know their skills deficiency and might need an assessment or 360-degree feedback, hence the need for awareness. All leaders in an organisation might need to be taught leadership principles that align with the organisation's values and culture—requiring consistency. Efficiency will drive good utilisation of training by those that need it most and will reduce wastage. Quality will ensure that the content of the training is based on the latest research and the coaches, mentors and expert trainers are professionally trained.

The current study found that survey respondents and interview participants improved deliberate practice when they integrated other leader development approaches with structured mentorship or coaching. By so doing, they would have a scheduled meeting with their coach (most times the coach-manager) or their mentor, with whom they discussed how the person has implemented or practices any action that they agreed to in the previous meetings. This accountability relationship ensured that the leader would apply lessons and insights from a book they are reading or a course they just concluded, if for no other reason than to not disappoint the coach or mentor when asked. Other practices that enhanced deliberate practice included having a formal personal development plan that outlines all the learning activities expected in the short (three months) and long-term (12 months). Such a plan would also be aligned to previously identified development needs, say through a 360-degree feedback assessment, performance appraisal, career planning or training needs assessment.

5.8 Implications of the findings

The study contributes to the literature by providing new insights into the leader development phenomenon, specifically in how—within the context of natural sciences and a developing country setting—leadership conceptualisation, leader-identity, self-efficacy, structural limitations, and subjective norms meaningfully attenuate the appetite for engagement in leader development activities. The study particularly expands the current understanding of the theory of expert leadership, specifically in how it integrates with two theories—social identity and planned behaviour, to illuminate on effective approaches in expert leadership development.

5.8.1 Expert leadership and planned behaviour theories

The theory of expert leadership as presented in the literature review (section 2.11.4) makes the case that leaders in technical fields such as natural sciences emerge differently compared to non-scientists and that, therefore, approaches to develop such leaders are unique, albeit not well understood. The current study contributes to the understanding of these approaches through the examination of leadership experiences of natural scientist supervisors and identifying effective leadership development approaches. The study findings align with Goodall (2016) articulation of the importance of inherent technical knowledge as a way of signalling expert leadership and consequently leadership emergence. The study also shows how expert leaders can be development through the integration of approaches that work. As a contribution to knowledge, the study demonstrates how the theory of expert leadership can be integrated within a framework of other leadership learning theories to study leader development within the specialist fields of agriculture, medicine and engineering.

The findings align with Ajzen's (1991) theory of planned behaviour which has argued that behaviour (for example, engaging in leader development activities) can be predicted by attitudes, subjective norms and perceived behavioural control. In the context of medical doctors in a resource-constrained setting such as Uganda, attitudes, subjective norms and perceived behaviour control were negatively associated with intention to engage in leader development activities.

However, Ajzen's (1991) theory is unable to explain the study findings on the influence of other contextual issues such as social identity, power-distance culture, organisational policies and systems, industry experiences such as undergraduate training customs and processes, and learning transfer environment on leader development behaviour. As such, the current study expands the application of Ajzen's (1991) theory of planned behaviour and proposes an emerging conceptual framework that could be a useful tool for future research. For example, future research to increase our understanding of the interplay between contextual influences, leader characteristics and the traditional aspects of Ajzen's (1991) model—attitudes, social norms, perceived behavioural control, intention, and behaviour can utilise the ABC model as a conceptual framework. Furthermore, the conceptual framework presented in Figure 2.2, section 2.11.7 comprehensively covers elements that the current study identified as strong influences on behaviour but are not explained by either the expert leadership theory nor the theory of planned behaviour.

The study demonstrates how the theory of planned behaviour can be used in a greater framework of expert leadership development. The theoretical implication, therefore, is that the study further confirms the applicability of Ajzen's (1991) theory of planned behaviour but integrates the theory with the addition of context and leader characteristics as concepts that intermediate the adoption of a behaviour (in this case participation in leader development). This is depicted in the conceptual framework that guided the current study.

5.8.2 Social identity theory

Furthermore, the study shows how context has a powerful impact on leader development as it affects both leader characteristics (such as attitude and perceived behavioural control) and developmental opportunities to perform the actual behaviour of participating in leader development. The study demonstrates the application of social identity theory in a greater framework of expert leadership development. The study findings appear to suggest that, in a context where social and subjective norms are strongly held, social identity might be a good explanatory theory for leader development as much as leader identity or leader learning efficacy (Avolio and Hannah, 2008; Hannah *et al.*, 2008; Lester *et al.,* 2011). For example, whereas natural scientists had strongly held views of themselves as leaders on the basis of technical qualifications and that the confidence in their intellectual ability was high (consequently believing that they could easily learn soft skills required for effective leadership), it appears that this social identity overshadowed leader-identity.

The social identity accrued from early days in medical, agricultural or engineering school, whereby comparing themselves to individuals from the humanities whom they considered intellectually inferior, scientists would not want to be classified as ‘penguins’ by engaging in soft-skills training purportedly befitting non-scientists. This perhaps made it challenging even for scientists who might have desired to learn soft skills, as doing so would lead to perceptions of exclusion from the scientists’ group, thereby diminishing social attraction, self-enhancement and uncertainty reduction (Hogg, 2001; Antonakis, House and Simonton, 2017). This phenomenon is consistent with social identity theory and suggests that social identity theory is a better explainer of leader development behaviour among natural scientists in Uganda than the theory of planned behaviour.

5.8.3 Implications for practice

From a practical standpoint, the study has practical implications for educators, policy elites and organisational development practitioners.

For educators

As the drive for improving leadership in the natural sciences escalates, for example, in physician leadership, it is imperative that attitudes towards soft skills and leadership among scientists are addressed early on in medical school. The value of leadership in improving patient outcomes and the effectiveness of physicians must be emphasised. Medical school curriculums should integrate leader and leadership development at various levels because they prepare future industry leaders, and such skills are cumulatively developed (Mumford, Campion and Morgeson, 2007; Torbeck, Rozycki and

Dunnington, 2018; Ziemba *et al.*, 2018). Moreover, clinical skills will be required less as one rises to the top (Perry, Mobley and Brubaker, 2017). Additionally, problem-based learning should be adopted by creating opportunities for medical students to engage in community health activities and interdisciplinary project teams where they interact and socialise with non-medical personnel—helping them learn valuable skills for leadership. The same can be done for engineering and agricultural students. Engineering and agricultural students need to engage in community activities early on to appreciate how to influence the community to adopt their inventions. Educators should also examine how to integrate time for reflection, socialisation and extracurricular activities like sports, community and student leadership for undergraduate students, as previous research shows leader development works better through experiential opportunities than the classroom (Yip and Wilson, 2010; Lees, 2019). As Lees' (2019) study among clinicians demonstrated, already full curricula make it difficult to learn leadership, given how much value is attached to clinical skills.

For policymakers

Organisations superintending the quality assurance and professional development of scientists such as the Uganda Medical Association, Uganda Institute of Professional Engineers and the Ministry of Agriculture should encourage leader development among their members. These organisations can also encourage scientists to participate in social and community initiatives and to take on leadership roles in the social, political and economic spheres as part of their leader development journey. Further, continuing professional education that focuses on soft skills should be encouraged. Policymakers at the national level should consider re-instituting the leadership and management training course at the Uganda Management Institute as a prerequisite before deployment of medical officers. Furthermore, by benchmarking against their non-scientists counterparts, policymakers in natural science-based institutions may consider including leadership training and qualifications as a prerequisite for promotion and career advancement and to promote leadership skills as a vital complementary skill to technical competencies (Sapienza, 2007; Lees, 2019; Baas, Dewhurst and Peyre, 2020).

For organisational development practitioners

Human resource development professionals in health care, engineering and agricultural scientist organisations should carefully consider incentives for technical personnel to enrol in leadership training, including providing time off or a more relaxed schedule that enables further study. In addition to scientific expertise and experience, incentives such as requiring formal leadership training and qualifications before one is considered for senior leadership roles are likely to improve interest in leader development. However, as Lees' (2019) study among clinicians concluded, a paradigm shift is needed to elevate the value of leadership skills and soft skills in general as it is often counter-cultural to natural scientists' mindsets. Such a cultural shift may mean institutionalising feedback and reviews beyond technical project outcomes to include team leadership evaluation, perhaps by integrating team leadership as a key performance metric for scientists supervising others. The study also implies that practitioners should invest more in mentorship, coaching, feedback, acting in leadership roles, formal leadership training and experiential learning as the main leader development approaches likely to bring more value to the organisation.

5.9 Limitations of the study

While the study brings additional clarity to the literature on leader development, it has inherent limitations. The findings of the current study should therefore be appraised through the filter of the following limitations.

First, the study used a small sample of scientists as the inclusion criteria were limited to those holding supervisory positions in the case study organisations. Yet, leadership, broadly defined, includes even those who may not have formal positions but have influence, and contribute to the process of attaining team goals. Therefore, only a few respondents were possible, which limits the generalisability of the study findings. However, to minimise the impact of a small sample, a census approach was used whereby all supervisors in the case organisations were invited to participate in the cross-sectional survey. Moreover, the mixed-methods approach triangulated findings from the survey with those from interviews and focus group discussions.

Secondly, the qualitative phase of the study used purposive sampling, which limits generalisability. Nonetheless, the limitations of a nonrepresentative sample were minimised by selecting doctors from multiple organisations and ensuring that a wide range of scientist sub-disciplines was selected from MAAIF, including engineers, crop scientists, entomologists, animal scientists, aquaculture scientists, among others. Additionally, qualitative interview participant selection continued until there was a degree of saturation (Corbin and Strauss, 2008). Thirdly, the nature of the scientist organisation was such that the majority of leaders in supervisory positions were 40 years and older. The study, therefore, misses out on early-career scientists, who might have different perceptions and experiences. Nonetheless, a benefit of studying older scientists was that the study identified a wide range of lifespan experiences for leader development, thereby more meaningfully compared the association between leader development and attendant leadership effectiveness.

Fourthly, the study was conducted in a Ugandan setting. Whereas this brings a fresh perspective to extant research on leadership, which is often conducted in developed country contexts and cultures, the findings may not be generalisable.

Fifthly, for pragmatic reasons, the study used self-reports to measure leadership effectiveness, exposing it to social desirability bias. Future studies may minimise this by using multi-rater approaches. Additionally, the study's ability to develop a quality scale instrument was diminished by scope and the principal investigator's limited experience in scale development.

CHAPTER SIX — CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter provides a synthesis and summary of the findings emerging from the study and their significance. It summarises the answers to the research questions posed by the study and details how the study contributes to the gaps previously identified in the literature. The chapter also makes explicit recommendations for further research and for practitioners that, it is hoped, when taken up, can improve the way scientists develop leadership skills. The chapter ends by underlining the contribution to knowledge that the study makes.

6.2 Conclusions

This study aimed to identify the leader development approaches that engender leadership effectiveness among natural scientists. Through the thematic analysis of qualitative data and a cross-sectional survey comparing natural scientists with non-scientists, along with a literature review, it can be concluded that coaching, mentorship, feedback, formal leadership training, acting in a leadership role and experiential learning are impactful approaches to nurture leadership skills among natural scientists. The study findings indicate that when the approaches above are undertaken by scientists possessing beliefs that cherish leadership skills in an environment supportive of leader development, such scientists are more likely to demonstrate higher leadership effectiveness. Consequently, the main aim of the study was achieved. Building on the theories of social identity and planned behaviour, the study also concludes that leadership conceptualisation, leader-identity, self-efficacy, organisational culture, and subjective norms, if not supportive, meaningfully attenuate the appetite for engagement in leader development activities.

6.2.1 Objective 1: Contextual influences on leader development

The study explored how attitudes, beliefs, subjective norms, intentions and experiences of leader development among natural scientists in Uganda differ from those of non-scientist leaders, with a view to identifying the contextual influences on leader development unique to natural scientist leaders in Uganda. Demonstrating what uniquely affects how scientists approach leader development brings additional clarity to what scientist leaders can do to make leader development more effective.

The study concluded that the conceptualisation of leadership as hierarchy and 'percussion' diminishes the impetus for scientists to engage in leader development. The study found evidence that leader-identity and self-view coupled with a social identity of superiority make scientists abhor soft skills.

Moreover, the study concluded that compared to non-scientists, the lack of leadership training in undergraduate programmes is typical for scientists. Further, not incorporating leadership in undergraduate curriculums for natural sciences diminishes the appreciation of leadership skills as complementary to technical competences. Consequently, scientists miss taking advantage of a developmental window at university, which previous research has established would lead to demonstrating leadership skills in the future. This preponderance of beliefs and social-identity in controlling behaviour is consistent with previous literature (Bandura, 1986; Ashforth and Mael, 1989; Ajzen, 1991; Tajfel and Turner, 2004; Ellemers and Haslam, 2012; Cassar, Bezzina and Buttigieg, 2017). Therefore, it can be concluded that without addressing the beliefs and significance that scientists attach to soft skills and leadership skills, right from their undergraduate and early career days, the effectiveness of whatever leader development approach is deployed is likely to be diminished.

Furthermore, the study concludes that systemic industry and organisational practices, policies and norms make it challenging for scientists to value, let alone engage in leader development. Specifically, the study found evidence that excessive workloads make it harder for scientists to engage in leader development. It also found that the diminished acceptance of a feedback culture and a limited supportive learning transfer environment for leaders to account for and practice what they have learned, all attenuate the impact of leader development activities. Moreover, the lack of incentives and policies to require leadership skills for leadership positions pushes scientists to focus on the only sure route for career progression and better remuneration—technical skills, leaving leader development to be approached haphazardly without intentionality and deliberate practice.

Additionally, compared to non-scientists, the study identified that there are few role models and mentors who demonstrate best practice in leadership, perpetuating a cycle of learning from bad practice, moreover in a community that predominantly learns through experiential learning and acting in a leadership role. Therefore, it can be concluded that benchmarking non-scientists organisations for policies and practices that elevate the value of leadership can enable organisations employing predominantly natural scientists to establish a contextual environment that cultivates and sustains effective leader development. These practices were identified as elevating the value of leadership skills through campaigns, hiring and promotion policies, managing workloads to provide time for leader development, and establishing formal leadership training programmes for staff.

6.2.2 Objective 2: Impactfulness of leader development approaches

The study sought to identify the leader development approaches considered more effective than others within the context of natural scientist leadership and establish why. By so doing, the study identified mentorship, experiential learning, feedback, acting in a leadership role, self-awareness and coaching as the most impactful approaches considered more effective for natural scientists. The study found that nearly all methods were considered relevant by non-scientists. Coaching was more impactful when delivered by trained professionals and when the relationship with the coachee is strong enough to provide psychological safety. The study found evidence that senior scientist leaders appreciate coaching for its personalised approach, confidentiality and the psychological safety it provides in comparison to other group learning methods. The study established that mentorship is more effective when mentors have also undergone some training in leadership and have learned best practices. Mentorship was less impactful when such mentors modelled the defective 'percussion' based hierarchical leadership styles that were in turn passed down by previous mentors who did not know better as they were not exposed to much leader development.

On why experiential learning and acting in a leadership role were considered impactful, the study concludes that scientists' use of experiential learning and acting in a leadership role as the de facto modes of leadership learning enables such methods to benefit from their powerful features such as challenging work, stretch assignments and learning from mistakes. Furthermore, self-awareness and feedback were considered impactful because they fill an important gap. Specifically, scientists in the study felt that self-awareness and feedback, when well utilised, enhance enlightenment and help leaders to address blind spots—something that is critically needed given the hierarchical nature of leadership in the natural sciences and the power-distance culture that makes it difficult for lower-ranking officers to provide constructive criticism or differing opinions.

Further, while formal leadership training was not among the top-ranking approaches considered effective among scientists, it was also found valuable when aligned to organisational outcomes, real-life problems and case studies and whenever a strong post-training learning transfer environment exists. The study concluded that within the scientists' organisation, motivations for attending training, at present, are monetary and that training is not often aligned to the leadership development needs of the individual or the organisation's outcomes.

6.2.3 Objective 3: Leader development and leadership effectiveness

The study sought to assess how the degree of exposure to particular leader development approaches relates to perceived leadership effectiveness among natural scientists. In so doing, the study established the levels of exposure to different leader development approaches. The study established that the approaches most natural scientists are exposed to include experiential learning, acting in leadership roles, self-directed learning and feedback. In contrast, non-scientists were more exposed to self-directed learning, acting in a leadership role and experiential learning. The approaches scientists were least exposed to included coaching, formal leadership training, mentorship and networking. The study concluded that scientists and non-scientists were similar in their exposure to leader development activities as significant differences were only found with experiential learning.

Furthermore, the study departs from previous literature when it found that scientists and non-scientists were comparable in their perceived levels of effectiveness. This was attributable to the use of self-reported assessment in the study, and a possible Dunning-Kruger effect (Dunning, 2011) but was better explained by the participant demographics whereby, scientists in the study were older and more senior in leadership—consequently having enhanced their effectiveness over a longer lifespan (Mumford, Marks, *et al.*, 2000; Mumford, Campion and Morgeson, 2007; Murphy and Johnson, 2011; Liu *et al.*, 2020). From the study findings, it can be concluded that the skills scientists need to be effective in leadership may be similar to those of their non-scientist counterparts, and therefore, scientists could benefit from training programmes and leader development opportunities that integrate cross-functional, cross-disciplinary and multi-profession attendees, and case studies. The sharing of scenarios, experiences, challenges and best practices across scientists and non-scientists may be beneficial.

The study also examined the relationship between exposure levels and perceived leadership effectiveness among natural scientists. Based on univariate ANOVA tests, it was found that higher exposure to mentorship, feedback, e-learning and formal leadership training is associated with greater effectiveness. However, through triangulation of quantitative and qualitative data and synthesising insights from the literature review, the study established that in the context of natural scientists, exposure to e-learning is a recent phenomenon and that extensive exposure and integration of feedback and coaching would be necessary to make e-learning impactful. Additionally, because of the ubiquitous access to experiential learning and acting in a leadership role among natural scientists, and because previous research has found these two methods to be highly impactful, the study concluded that such approaches are likely to engender leadership effectiveness among scientists.

6.2.4 Objective 4: Conclusions on approaches that engender leadership effectiveness

The study sought to explore and recommend leader development approaches and practices likely to lead to higher leadership effectiveness among natural scientists. Based on the thematic analysis of qualitative and quantitative data, and a review of the literature it can be concluded that (1) coaching, (2) mentorship, (3) feedback, (4) formal leadership training, (5) acting in a leadership role and (6) experiential learning are the recommended leader development approaches likely to engender leadership effectiveness among natural scientists.

However, while the study found evidence that each of these six approaches is associated with increased leadership effectiveness, nuanced analyses of how each is best deployed are important and need to be in place to fully optimise the potential in an approach. Furthermore, the study established that an approach, in itself, is insufficient to engender leadership effectiveness unless it is paralleled by a confluence of supportive beliefs amongst the leader(s) under development and an organisational and industry environment that cherishes leadership skills and fosters leader development. Moreover, congruent with extant literature suggesting that exposure to more than one approach yields greater results (Aitken and Higgs, 2010; Cullen-Lester, Maupin and Carter, 2017; Lacerenza *et al.*, 2017; Kjellström, Törnblom and Stålne, 2020), the study further concludes that integrating feedback and coaching improves other approaches. The identification of impactful context-appropriate approaches notwithstanding, the current study did not establish the ideal mix. Further studies are necessary to identify the ideal mix of approaches.

6.2.5 Objective 5: Conclusions on a model for leader development

The study used the emerging themes from the data to develop a model/framework that future researchers and practitioners could use to improve leader development. Therefore, it can be concluded that for leadership effectiveness to occur as an outcome of leader development efforts, a confluence of four dimensions—ABCD—consequently christened ‘the ABC model of leader development’ should occur. These dimensions include A-Approaches that work, B-Beliefs that motivate, C-a Context that supports and D-deliberate practice that perpetuates learning. The approaches include the six methods identified above alongside the implementation of Pollock’s *et al.* (2015) six disciplines of breakthrough learning in the way the six approaches are deployed. Beliefs include promoting attitudes and mindsets that espouse leadership skills and acknowledging that not all popcorn pops—consequently identifying developmentally-ready leaders (for example those demonstrating ambition and self-motivation) as priority candidates for leader development investments. Context includes nurturing a culture of feedback, institutionalising policies and incentives that elevate leadership skills, including leadership skills in medical, engineering and agricultural students' curriculums and revolutionising a shift in educational methods for technical personnel to include social, networking and community leadership experiences.

6.3 Recommendations

The study makes the following recommendations.

6.3.1 Recommendations for future research

Notwithstanding that the study found evidence for the effectiveness of six approaches (coaching, mentorship, feedback, formal leadership training, acting in a leadership role and experiential learning) and how each could be enhanced through complementary consort with another, further studies are necessary to establish the optimal combination and mix that delivers high leadership effectiveness, quickly. Such studies would inform ways in which leader development could be accelerated for scientists who hold positions and need speedy leadership skills development.

Furthermore, there are limitations to the current study that constrain the ability to generalise the findings. As outlined in section 5.9, the study had a small sample of leaders, mostly senior. Future studies should enlist a larger sample and include junior leaders. Moreover, the organisational cultures studied in the current study may not be representative of all natural science institutions. Further studies may look into other organisational contexts and, more broadly, other country contexts.

Additionally, the current study did not use a multi-rater approach to measuring leadership effectiveness which exposes it to social desirability bias. Such an approach requires preparing the organisation for such an activity and training raters to appreciate how to give feedback—something pragmatically outside the scope of the current study. Further studies should consider using the 360-degree multi-rater leadership assessment in order to have a more robust measure of leadership effectiveness as an outcome variable.

6.3.2 Recommendations for practice

Based on the study conclusions, practitioners, educators, and policymakers should consider the following:

- Educators should consider reviewing the existing curriculum at the undergraduate level to include leadership skills and soft skills in general as a critical component of what scientists need to succeed in their industry
- Educators may also consider adopting innovative pedagogical approaches that integrate collaborative projects and community-based action learning projects that enable natural scientists to interact in an interdisciplinary fashion and to learn more through problem-based case study approaches.
- Educators and organisational development practitioners should consider dedicating and delineating time for social activities, networking, sports and community engagement activities that draw on and build the scientists' emotional and social intelligence competencies rather than overloading them with excessive technical studies or technical work that keeps them focused only on the technical competences. Efforts should be made to shift the culture where technical personnel spend most of their early careers isolated and immersed in technical activities.
- Policymakers and organisational development practitioners should consider benchmarking non-scientists organisational cultures and policies such as requiring leadership training and the demonstration of leadership skills before one is given a leadership position despite their domain experience and technical expertise.
- Practitioners should consider the four elements in the ABC model when evaluating and analysing what aspects of their current leader development efforts are working and which ones are derailing the process. Additionally, the model may be used when designing new programmes by examining each element in the framework to assess compliance and confluence and alignment with the rest of the elements.
- Human resource development professionals in health care, engineering and agricultural scientist organisations should carefully consider incentives for technical personnel to enrol for leadership training, including providing time off or a relaxed schedule that enables further study.
- Policymakers at the national level should consider re-instituting the leadership and management training course at the Uganda Management Institute as a pre-requisite before deployment of medical officers, engineers and agriculturists.

6.4 Contribution to knowledge

The purpose of the study was to identify the leader development approaches that engender leadership effectiveness among natural scientists. This study illuminates what previous research has identified as a lack of clarity in what methods, approaches, plans, and processes of leader development lead to better leadership effectiveness in specific contexts (DeRue and Myers, 2014; Miles and Scott, 2019). Examining what approaches engender effectiveness was particularly urgent in the context of Uganda and natural scientists in particular because many organisations are increasingly electing scientists to take on leadership roles and spending colossal sums of money to invest in leader development (Perry *et al.*, 2017; The East African, 2018; The Independent, 2019; Daily Monitor, 2020; The Observer, 2020).

The study contributes, first, by studying the phenomenon of leader development in a developing country context. Most studies in the literature focus on developing country contexts and culture, limiting generalisability and utility in Africa (Guthrie, 1999; Wright *et al.*, 2000; McAlearney, 2005, 2006; Farr and Brazil, 2009; Kiruhi, 2013; Gumede, 2017). Second, previous studies examining leader development among scientists have limited their focus mostly to the medical fields (Guthrie, 1999; Davidson *et al.*, 2012; Saxena *et al.*, 2014; Geerts, Goodall and Agius, 2020), limiting the generalisability across natural science disciplines. This study contributes to the existing literature by integrating medicine, engineering and agricultural cases to provide a broader view of natural scientists in general. Moreover, in terms of methodology, previous studies of scientists were not comparative in nature. The current study being comparative, explains the scientists' case but goes further to establish the extent to which such explanation is unique to scientists and not just to leaders in general. In the absence of a control group, the comparative case study approach provides additional rigour and empirical data in consort with previous studies though adding nuances and clarity in some of the gaps previously identified.

A significant contribution of the study is the development of a conceptual framework rooted in the existing literature and the ABC model of leader development—rooted in empirical data. Both the conceptual framework and ABC model are useful tools for further research and for practice. They can be utilised to comprehensively examine the relationships between specific leader development activities and leadership effectiveness. Additionally, the study established a tool for measuring leadership effectiveness using scales assessing the demonstration of capabilities in ten dimensions that included: (a) role ownership, (b) emotional intelligence, (c) servant leadership, (d) strategic thinking, (e) ethics and accountability, (f) performance management, (g) decision making and problem solving, (h) team leadership, (i) communication skills, (j) innovation and creativity. The tool which also included scales for assessing the determinants of leader development that was found to have high validity and reliability. Future researchers and practitioners can use this tool.

Furthermore, the study adds to a body of theory by emphasising how social identity has a powerful impact on leader development—affecting both leader characteristics (such as attitude and perceived behavioural control) and developmental opportunities to perform the actual behaviour of participation in leader development. In so doing, the study confirms the applicability of Ajzen's (1991) theory of planned behaviour to leader development amongst natural scientists. Moreover, the study demonstrates how the TPB can be integrated with social identity and expert leadership theories and suggests a conceptual framework that adds context and leader characteristics as concepts that intermediate the adoption of a behaviour. Conversely, the study departs from previous studies on the powerful influence of self-efficacy and learning efficacy (Avolio and Hannah, 2008; Hannah *et al.*, 2008; Lester *et al.*, 2011) by suggesting that in a context where social and subjective norms are strongly held (such as among specialist natural scientists) social identity might better explain influence on leader development compared to leader learning efficacy or self-efficacy.

Previous research reports that due to the exorbitant costs of leader development, scholars and practitioners are calling for "further empirical clarification about specific, effective approaches to, and benefits of, different types of leadership programs" (Geerts, Goodall and Agius, 2020, p. 14). Other studies have pointed to the struggles organisations and leaders have in identifying appropriate methodologies or how such can be effectively deployed to learn leadership—with leader development continuing to be approached haphazardly due to a dearth of literature on effective approaches (Conger, 1993, 2004; Kaagan, 1998; Conger and Toegel, 2002; Sapienza, 2007; Avolio and Hannah, 2008; Hannah *et al.*, 2008; Avolio, Avey and Quisenberry, 2010, 2010; Day, 2010; Leonard and Lang, 2010; Kouzes and Posner, 2012; Day *et al.*, 2014; Heslin and Keating, 2017; Lacerenza *et al.*, 2017; Geerts, Goodall and Agius, 2020; Kjellström, Törnblom and Stålne, 2020; Liu *et al.*, 2020).

The current study contributes to addressing this gap by providing clarity on the approaches that are most linked to leadership effectiveness, providing nuances on how to deploy them effectively and illuminating the contextual facilitators and impediments to leader development. For example, the study suggests that leadership conceptualisation, leader-identity, self-efficacy, structural limitations, and subjective norms, when not supportive, meaningfully attenuate the appetite for leader development activities. The study also outlines what educational architects and policy elites charged with educational responsibility within the natural sciences can do to close critical leadership gaps at various levels of the organisation. It makes recommendations to different stakeholders (including academic institutions) to better prepare natural scientists for leadership roles in organisations. The study recommends a context-appropriate and potentially potent process through which a wide range of natural sciences leaders can be developed.

Furthermore, the study makes a contribution to the field through the presentation and publication of the findings. For example, the findings on how leadership conceptualisation impacts leadership development among medical doctors in Uganda were presented at the 3rd International Conference on Research in Teaching and Education in Berlin (15-17, December, 2020). Additionally, research papers arising from the study have been prepared for publication in peer reviewed journals. Furthermore, presentations were made at the two participating case study institutions (URA and MAAIF) to disseminate the finding to provide insight into effective leader development and reduce the blind deployment of activities, processes, and methods that may not be as effective.

6.5 Conclusion

The primary purpose of this study was to identify the leader development approaches that engender leadership effectiveness among natural scientists. The study showed how the theory of expert leadership can be integrated with social identity and planned behaviour theories to examine leader development experiences of expert leaders and identify effective approaches. This chapter outlined how the study answers all the five research questions and attendant objectives and contributes to the body of knowledge. The chapter recommended that coaching, mentorship, feedback, formal leadership training, acting in a leadership role, and experiential learning are impactful approaches to nurture leadership skills among natural scientists. The chapter also emphasised how the study builds on the theories of social identity and planned behaviour to conclude that the six approaches are made more effective when beliefs and contextual factors are supportive to leader development. The study concludes that leadership conceptualisation, leader-identity, self-efficacy, organisational culture, and subjective norms, if not supportive, meaningfully attenuate the appetite for engagement in leader development activities.

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APPENDICES

Appendix 1—Key informant interview guide

KEY INFORMANT IN-DEPTH INTERVIEW GUIDE

Leader Development among Natural Scientists in Uganda

Introduction
(See Information Sheet—Appendix 2)

Overarching Research Question

How do leaders in technical fields approach leader development and why are specific leader development approaches effective and appropriate to their unique challenges and context?

Section 1: General Questions

1.1. Tell me about you and your leadership role in your organisation
1.2. What can you tell me about leadership in your field in general.
1.3. How would you say the learning of leadership in your field differs from other (scientists vs non-scientist/) fields?
1.4. What do leaders in technical fields consider to be the most important/relevant approaches for leader development? (Probe for rationale/why?)
1.5. In your organisation, what are your policies, practices and experiences for developing leaders?
1.6. In your organisation, what leader development practices appear to produce the best results? Why so?
1.7. How is leader development connected to career development, performance management and promotions?
1.8. What attitudes do people in your field hold towards leadership training and soft-skills in general? (Probe for perception on comparator—scientists vs non-scientist)
1.9. What would your peers say when they learn that you have enrolled and are regularly participating in leader development activities? What informs that view?
1.10. What obstacles usually stand in the way of people like you in developing your leadership capability? (Probe for perception on comparator—scientists vs non-scientist)

Section 2: Leadership Skills and Competences

2.1. What leadership skills, qualities and competences are most critical for people in your field to have? Why? (Probe for perception on comparator—scientists vs non-scientist)
2.2. What are the most impactful ways to develop these skills?

Section 3: Contextual Factors

3.1. How has your technical/formal training in the past prepared you for leadership? In which ways has it NOT prepared you for leadership?
3.2. How did you become a leader? How do leaders emerge in your field?
3.3. What unique experiences can you attribute to having enabled you to develop leadership skills?
3.4. What would you say are the features that make the learning of leadership different in your field/professional area?
3.5. What specific leadership development activities, programmes, interventions have you participated in?
3.6. Which ones were the most effective (probe for why)?

3.7. Which ones were the least effective (probe for why)?
3.8. What would be a critical consideration for any leadership development programme in your field to be effective?
3.9. What attitudes make it easy or difficult for technical people to learn leadership?

Section 4: Leader Development Approaches

4.0 Thinking back about your leader development process, how have the following activities contributed to your growth?

4.1 Feedback

- How would you describe the practice of giving and receiving feedback within your organisation? How about in the field of technical professionals in general?
- What is your view on the value of feedback in the development of a leader?
- In your experience, what kind of feedback do leaders in technical field receive and how does this impact how they grow in their leadership?

4.2 Self-Awareness

- Thinking back about your leader development process, how has being self-aware contributed to your growth?
- How much of self-awareness training and processes is promoted within your field/industry?
- What perceptions do leaders in your field hold about psychometric tests and other self-awareness tools
- In which ways have you seen self-awareness contribute to the making of leaders within your field?

4.3 Formal Leadership Training

- What formal leadership training programmes have you attended?
- How relevant were these to your job/your field

4.4 Action Learning/After Action Reviews and Reflections

- What is your experience participating in reflective processes such as After Action Reviews?
- How have projects and team based problem solving enhanced your learning of leadership?
- How have these events contributed to your learning of leadership?
- What makes such approaches effective in learning leadership in your field? What hinders the effectiveness of this approach to leadership development in your field?

4.5 Experiential Learning/Projects/Action Learning

- How has experiential learning in the form of on-the-job training been a part of your leadership development journey?
- How have you integrated intentional reflection in your learning?
- What experiences have contributed greatest to your learning of leadership?
- What experiences have been the least useful?
- To what extent has giving leaders challenging work contributed to their learning of leadership?

4.6 360 Degree Leadership Assessments

- Tell me about your experience with 360 degree assessments?
- How have such assessments contributed to the development of leadership skills and competences?

4.7 Mentoring

- What has been your experience with mentors? (Probe for formal/informal, structured/unstructured)
- How widespread is the use of mentors and mentorship approaches in leader development in your field?
- What makes mentoring effective in your field? What hinders the effectiveness of this approach to leadership development?

4.8 Coaching

- What has been your experience with coaching/coaches? (Probe for formal/informal, structured/unstructured)
- How widespread is the use of coaches and coaching approaches in leader development in your field?
- What makes coaching effective in your field? What hinders the effectiveness of this approach to leadership development in your field?

4.9 Short courses

- What has been your experience with short courses in leadership? (Probe for formal/informal, structured/unstructured)
- How widespread is the use of short courses as an approach to leader development in your field?
- What makes short courses effective in your field? What hinders the effectiveness of this approach to leadership development in your field?

4.10 Self-Directed Learning

- Tell me about your experience with self-directed learning in leadership? (Probe for types)
- How widespread is the use of self-directed learning as an approach to leader development in your field?
- What makes self-directed learning effective in your field? What hinders the effectiveness of this approach to leadership development in your field?

4.11 Benchmarking

- Tell me about your experience with benchmarking in learning leadership? (Probe for types)
- How widespread is the use of benchmarking as an approach to leader development in your field?
- What makes benchmarking effective in your field? What hinders the effectiveness of this approach to leadership development in your field?

4.12 Technical Skills Training/Undergraduate/Graduate Training

- Tell me about your experience learning leadership during your technical training (Probe for events)
- To what extent is leadership training integrated within technical skills training?

- What value is placed on leadership skills development during your technical training? Why is that so? (Probe for perceptions at student level, teacher level and institutional levels; culture, values, and nature of training e.g., classroom, internship, industrial training)
- What makes learning of leadership during technical training effective in your field? What hinders the effectiveness of this approach to leadership development in your field?

4.13 Soft-Skills Training

- What value is placed on soft-skills in general? Why is that so? (Probe for perceptions at student level, teacher level and institutional levels; culture, values, and nature of training e.g., classroom, internship, industrial training)

4.14 Online/Blended/e-learning

- Tell me about your experience with online/blended or e-learning in leadership? (Probe for types)
- How widespread is the use of e-learning as an approach to leader development in your field?
- What makes e-learning effective in your field? What hinders the effectiveness of this approach to leadership development in your field?

4.15 Academic/Postgraduate Technical Courses

- Tell me about your experience learning leadership as part of your academic/technical training?
- How much of leadership and soft-skills training was emphasized? What areas of leadership was this training focused on?
- What makes integrating leadership training in the academic technical training effective? What hinders the effectiveness of this approach to leadership development in your field?

Appendix 2—Informed consent form for interviews

INFORMED CONSENT FORM

Part I: Information Sheet

Introduction

My name is Julius Lukwago and I am a student at UKZN where I am studying for a PhD in Leadership Studies.

I am conducting research study for my thesis. The study seeks to understand what leader development approaches are prevalent, preferred among leaders in technical fields (natural sciences) and that engender effectiveness. I am going to give you information about the study and invite you to be part of this research. In addition, if you agree to participate, I am going to ask your permission to record our conversation for the sole purpose that I will remember everything we have discussed.

Participation

You are being invited to consider participating in the study not because anything is known about you, save that you represent people who are leaders in technical fields or you are very familiar with the issues of leadership in technical fields/natural sciences. What you will tell me will strictly be confidential and your name will be disguised in all documents associated with this research. You will be asked questions about your experience, knowledge, and opinions on leadership. There are no wrong answers, and hence you will not be judged.

Voluntary participation and withdrawal

You are free to choose whether to take part in this study or not, although I would be most grateful if you accepted to participate. If you choose not to take part, you will not be negatively affected in any way. If you choose to participate, you may stop at any time without any penalty if you so wished. You do not have to decide quickly whether or not you will participate in the research.

Before you decide, take your time. If there is anything that you do not understand, ask me to clarify the information and I will take time to explain. If you accept to participate you will also be asked to allow me to record this conversation.

Purpose of the research

The study aims to develop a deeper understanding of how leaders develop within technical fields and what approaches are most effective in accelerating leadership development in this context. The study will enable us to identify what leader development approaches are linked to greater effectiveness among leaders in technical fields. The results will be used to improve the way leaders in technical fields are developed or nurtured and consequently help in the improvement of how organizations in these fields are run. It will help to postulate a model for helping technical leaders to be more effective.

Selection of participants

20 people from your organization have been invited to participate in this study. 20 other leaders will be invited from one other participating organization. The selection was not random but you were chosen because of your position in the organization and because your organization feels that you have a considerably understanding of leadership issues within the organization, industry or technical fields in general. The information you provide can contribute much to our understanding and knowledge of leadership in technical fields.

Type of Research

Your participation in the study is completely voluntary and will involve answering questions that will take about 45 minutes. The questions ask about your perception and experience in leadership.

Risks, Discomforts and Right to refuse or withdraw

The potential for any harm is quite low, if any. However, there is some risk that you may feel uncomfortable talking about some topics or that you may share some personal or confidential information by chance. We do not wish for this to happen. Thus, at any time, you can choose not to answer any questions. You may also choose to opt out of the study at any time. Also, we will make sure that your taking part in this study will be kept a secret. Nobody outside of our team will know that you were in the study. All files will be kept in locked cabinets. Your name will not be recorded anywhere.

Benefits, Incentives and Costs

There is no direct benefit to you for participating in the study and no monetary or any other incentive will be provided. There are equally no costs to you for participating in this study other than the time you will spend during this interview. The interview will last utmost 45 minutes.

However, we hope that you will participate since your views are important for the study and the results from the study will improve the way leaders are developed. We can schedule the interview for another time if it is more convenient to you.

Confidentiality

Your name, address or any other information that could identify you personally is not being recorded. Your responses are strictly confidential and will not be shared with anyone else outside the study team which includes me, my supervisor and the person who will do the transcribing (typing out what we have recorded). The information that we collect for this research project will be kept private. None of the information you provide for this study will be given to your organization except in a report form that provides aggregated feedback from all study participants.

Any information from you will have a number on it instead of your name. Only the researchers will know what your name is and we will lock that information up under lock and key. You can refuse to answer any specific question, or stop the interview at any time. If you chose not to answer a question, stop the interview or even not participate at all in the study, it will not affect your working conditions today or in the future.

Sharing the Results

The knowledge that we get from this research is primarily for the purpose of completing my PhD but may later be shared nationally and internationally. The results will be published so that other interested people may learn from the research.

Approval for this study

You may wish to know that this study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (approval number HSSREC/00000933/2020), as well as the Uganda Christian University Research Ethics Committee (approval number 29.10.603/2) in accordance with the Uganda National Council of Science and Technology regulations to ensure that research participants are protected from harm.

Who to contact

If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact any of the following:

1. Julius Lukwago
PhD Student
jlukwago@solutionsafrica.com
Tel. +256752862973

2 . Prof. Ana Martins
Supervisor
MartinsA@ukzn.ac.za

3. UKZN Humanities & Social Sciences Research Ethics Committee

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557- Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

4. UCU Research Ethics Committee

Prof. Peter Waiswa
Chairperson Uganda Christian University REC
Kampala, UGANDA
Tel: +256772405357
Email: pwaiswa@musph.ac.ug

Part II: Certificate of Consent

I ____________________ have been informed about the study entitled, “Leader development approaches that engender leadership effectiveness among natural scientists in Uganda: a comparative study” by Julius Lukwago.

I understand the purpose and procedures of the study

I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at jlukwago@solutionsafrica.com Tel. +256752862973

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557 - Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

UCU Research Ethics Committee

Prof. Peter Waiswa
Chairperson Uganda Christian University REC
Kampala, UGANDA
Tel: +256772405357
Email: pwaiswa@musph.ac.ug

By participating in this online/telephonic interview, I hereby provide consent to

Audio-record my interview / focus group discussion by saying, “YES I CONSENT”

Appendix 3—Informed consent form for survey

INFORMED CONSENT FORM—SURVEY

Part I: Information Sheet

Introduction

My name is Julius Lukwago and I am a student at UKZN where I am studying for a PhD in Leadership Studies. I am conducting research study for my thesis. The study seeks to understand what leader development approaches are prevalent, preferred among leaders in technical fields (natural sciences) and that engender effectiveness.

Participation

You are being invited to consider participating in the study not because anything is known about you, save that you represent people who are leaders in your organisation. The responses to the questionnaire will strictly be confidential and your name will not be captured, so the information will remain anonymous. You will be asked questions about your experience, knowledge, and opinions on leadership. There are no wrong answers, and hence you will not be judged.

Voluntary participation and withdrawal

You are free to choose whether to take part in this study or not, although I would be most grateful if you accepted to participate. If you choose not to take part, you will not be negatively affected in any way. If you choose to participate, please complete the survey. Before you decide, take your time. If there is anything that you do not understand, please contact me to clarify the information and I will take time to explain. By taking this survey, you have accepted to participate and given consent for us to use the information you provide for the study.

Purpose of the research

The study aims to develop a deeper understanding of how leaders develop within technical fields and what approaches are most effective in accelerating leadership development in this context. The study will enable us to identify what leader development approaches are linked to greater effectiveness among leaders in technical fields. The results will be used to improve the way leaders in technical fields are developed or nurtured and consequently help in the improvement of how organizations in these fields are run. It will help to postulate a model for helping technical leaders to be more effective.

Selection of participants

Nearly 200 leaders from your organization have been invited to participate in this study. Another 200 have been invited to represent another organization. The selection was to all leaders and supervisors at various levels of the organization. The information you provide can contribute much to our understanding and knowledge of leadership in technical fields.

Type of Research

Your participation in the study is completely voluntary and will involve answering questions that will take about 25 minutes. The questions ask about your perception and experience in leadership.

Benefits, Incentives and Costs

There is no direct benefit to you for participating in the study and no monetary or any other incentive will be provided. There are equally no costs to you for participating in this study other than the time you will spend completing the questionnaire. The questionnaire completion will take approximately 25 minutes.

Confidentiality

Your name, address or any other information that could identify you personally is not being recorded. Your responses are strictly confidential and will not be shared with anyone else outside the study team which includes me, and my supervisor. The information that we collect for this research project will be kept private. None of the information you provide for this study will be given to your organization except in a report form that provides aggregated feedback from all study participants. Any information from you will have a number on it instead of your name.

Sharing the Results

The knowledge that we get from this research is primarily for the purpose of completing my PhD but may later be shared nationally and internationally. The results will be published so that other interested people may learn from the research.

Approval for this study

You may wish to know that this study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (approval number HSSREC/00000933/2020), as well as the Uganda Christian University Research Ethics Committee (approval number 29.10.603/2) in accordance with the Uganda National Council of Science and Technology regulations to ensure that research participants are protected from harm.

Who to contact

If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact any of the following:

1. Julius Lukwago
PhD Student
jlukwago@solutionsafrica.com
Tel. +256752862973

2 . Prof. Ana Martins
Supervisor
MartinsA@ukzn.ac.za

3. UKZN Humanities & Social Sciences Research Ethics Committee
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4000
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Tel: 27 31 2604557- Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

4. UCU Research Ethics Committee
Prof. Peter Waiswa
Chairperson Uganda Christian University REC
Kampala, UGANDA
Tel: +256772405357

Email: pwaiswa@musph.ac.ug

Part II: Certificate of Consent

I have been informed about the study entitled, "Leader development approaches that engender leadership effectiveness among natural scientists in Uganda: a comparative study" by Julius Lukwago. I consent voluntarily to be a participant in this study and understand that I have the right to withdraw from the survey at any time without in any way affecting my job.

I understand the purpose and procedures of the study. If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at jlukwago@solutionsafrica.com Tel. +256752862973. If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
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Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557 - Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

UCU Research Ethics Committee

Prof. Peter Waiswa
Chairperson Uganda Christian University REC
Kampala, UGANDA
Tel: +256772405357
Email: pwaiswa@musph.ac.ug

By proceeding to take the survey, I hereby provide consent to use the information I provide for the study.

Appendix 4—Survey Questionnaire

Leader Development among Natural Scientists in Uganda

Section 1: Socio-demographical Information

No.	Question	Response	Code
	Q1.1 What organization are you affiliated to?	URA Ministry of Agriculture Uganda Medical Association Other	1 2 3 4
	Q1.2 What technical field describes you best	Crop Scientist Animal Scientist Aquaculture Engineering Medicine Agriculture Forestry Non-Scientist Other (Specify)	1 2 3 4 5 6 7 8 9
	Q1.3 Sex	Male Female	1 2
	Q1.4 Which age bracket best represents you	20- 29 30-39 40-49 50 and above	1 2 3 4
	Q1.5 What is the highest education level attained?	"A" level University/Tertiary Masters PhD Post-Doctoral	1 2 3 4 5
	Q1.6 What is your level of management responsibility?	Not a supervisor Frontline Supervisor Middle Manager Senior Manager Executive/Director Level	1 2 3 4 5

Section 2: Leadership Effectiveness

Item

Questions 2.1 For each of these statements select the response that best describes the frequency of how you demonstrate these leadership behaviours, competencies or skills where:

1 = Never—Never demonstrates competence
2 = Seldom—Rarely demonstrates competence
3 = Sometimes—Occasionally demonstrates competence
4 = Often—Generally demonstrates competence
5 = Always—Continually demonstrates competence

Item	Dimension 1	1	2	3	4	5
I take personal responsibility for team failures	Role ownership					
I convey an exciting and compelling view of the future	Role ownership					
I ask for feedback for improvement	Role ownership					
I am aware about the organization's strengths and weaknesses	Role ownership					
I approach my work with enthusiasm	Role ownership					
I demonstrate technical competence in my area	Role ownership					
Item	**Dimension 2**	**1**	**2**	**3**	**4**	**5**
I am sensitive to the feelings of others	Emotional Intelligence					
I see situations from the others' perspective	Emotional Intelligence					
I am approachable	Emotional Intelligence					
I treat others with dignity and respect	Emotional Intelligence					
I am aware of how my behaviour affects others	Emotional Intelligence					
I stay calm in difficult situations	Emotional Intelligence					
Item	**Dimension 3**	**1**	**2**	**3**	**4**	**5**
I model the behaviours I expect of others	Servant Leadership					
I act with humility	Servant Leadership					
I sacrifice personal interests for the success of others	Servant Leadership					
I constantly look for ways to add value to others	Servant Leadership					
I demonstrate commitment to personal values	Servant Leadership					
I seek out coaching and advice	Servant Leadership					
Item	**Dimension 4**	**1**	**2**	**3**	**4**	**5**
I act with a clear purpose	Strategic Thinking					
I prefer to ask why questions to develop an understanding of problems	Strategic Thinking					

I ignore past decisions when considering current similar situations (r)	Strategic Thinking					
I understand diverse changes in internal and external environment of the organization	Strategic Thinking					
I consider how I could have handled the situation after it was resolved	Strategic Thinking					
Seeing the big picture comes easily for me	Strategic Thinking					
Item	**Dimension 5**	**1**	**2**	**3**	**4**	**5**
I am open and transparent	Ethics & Accountability					
I act consistently with my core values	Ethics & Accountability					
People can count on me to do the right thing even when it won't be popular	Ethics & Accountability					
I am honest and straightforward	Ethics & Accountability					
I follow through on my commitments	Ethics & Accountability					
I am aware of my strengths and shortcomings	Ethics & Accountability					
Item	**Dimension 6**	**1**	**2**	**3**	**4**	**5**
I communicate crystal clear plans and strategies	Performance Management					
I holds others accountable for their performance	Performance Management					
I provide well-intentioned performance feedback	Performance Management					
I help the team excel and produce results	Performance Management					
I encourage people to make improvements in their work	Performance Management					
When dealing with subordinates, I can be tough or supportive depending on what the situation demands	Performance Management					
Item	**Dimension 7**	**1**	**2**	**3**	**4**	**5**
I treat mistakes, errors, and setbacks as valuable learning experiences	Decision making and Problem Solving					
I own up to the decisions I make	Decision making and Problem Solving					
I consider many options and seek out ideas from a variety of sources before making decisions	Decision making and Problem Solving					
In times of ambiguity and difficult change, I stay calm and positive	Decision making and Problem Solving					
I encourage diverse points of view	Decision making and Problem Solving					

I think through the longer-term implications and risks of alternative courses of action before deciding which to pursue	Decision making and Problem Solving					
Item	**Dimension 8**	**1**	**2**	**3**	**4**	**5**
I empower and develop others	Team Leadership					
I am a positive influence on the energy and motivation of my team	Team Leadership					
I appreciate individuals for their contribution to the team	Team Leadership					
I create a sense that each person's job is significant and important	Team Leadership					
I foster team cohesion	Team Leadership					
I work hard to find consensus in conflict situations	Team Leadership					
Item	**Dimension 9**	**1**	**2**	**3**	**4**	**5**
I am able to sense the emotional undercurrents in my group	Communication Skills					
I am content with the way my communication with my co-workers is going	Communication Skills					
My co-workers and I can speak openly with one another	Communication Skills					
I encourage inquiries from subordinates concerning clarification of the decision being made	Communication Skills					
I listen attentively to others' concerns	Communication Skills					
I argue persuasively for my point of view	Communication Skills					
Item	**Dimension 10**	**1**	**2**	**3**	**4**	**5**
I challenge the status quo by exploring new ways to achieve goals and overcome obstacles, and I encourage others to do the same	Innovation & Creativity					
I constantly search for ways to improve existing processes and approaches	Innovation & Creativity					
I make adequate time available to purse create ideas	Innovation & Creativity					
I encourage creative ways to solve problems	Innovation & Creativity					
I provide my team with opportunities for development and displaying talent even when I know they will make mistakes as they try new things	Innovation & Creativity					
I don't take credit for other people's ideas	Innovation & Creativity					

Section 3: Determinants of Leader Development Behaviour (Attitudes, Perceptions, Interest)

Item

Questions 3.1 For each of these statements select the response that best describes how much you agree with the statement.

1 = Strongly Disagree
2 = Disagree
3 = Neither Agree nor Disagree
4 = Agree
5 = Strongly Agree

Item	Dimension	1	2	3	4	5
Leadership decisions within a technical setting should be left to technical experts (r)	Attitude					
I am well informed about what a leadership position in my field requires	Attitude					
Opportunities for technical experts to develop managerial/leadership skills should be promoted widely	Attitude					
I already have the skills needed to lead; no further leadership development is needed (r)	Attitude					
Getting good in leadership skills is not as important as getting good in technical competences (r)	Attitude					
Item	**Dimension**	**1**	**2**	**3**	**4**	**5**
Participating in leadership development activities is essential for me to excel in my work	Outcome Expectations					
Developing my leadership skills will enable me to take on senior leadership roles in my career	Outcome Expectations					
It is important for technical experts to have managerial/leadership responsibilities	Outcome Expectations					
Individuals with training and experience in leadership are more likely to get results for their technical teams	Outcome Expectations					
The more one participates in leadership development activities, the more likely for them to be effective in leading technical teams.	Outcome Expectations					
Item	**Dimension**	**1**	**2**	**3**	**4**	**5**
Most people who are important to me think that I should participate in leadership development activities	Subjective Norm					
It is expected of me to participate in leadership development activities	Subjective Norm					
My peers believe that participating in leadership development activities is important	Subjective Norm					

Most technical experts I know regularly participate in leadership development activities	Subjective Norm					
It's normal for people like me to regularly engage in leadership development activities	Subjective Norm					
Item	**Dimension**	**1**	**2**	**3**	**4**	**5**
I am confident that I could develop my leadership capacity if I wanted to	Perceived Behaviour Control—Self-Efficacy					
For me to regularly participate in leader development activities is impossible (r)	Perceived Behaviour Control—Self-Efficacy					
The decision to develop my leadership capability is beyond my control (r)	Perceived Behaviour Control—Controllability					
Leadership is for people like me	Perceived Behaviour Control—Controllability					
It is not difficult for me to participate in leadership development activities	Perceived Behaviour Control—Controllability					
Item	**Dimension**	**1**	**2**	**3**	**4**	**5**
I plan to participate in leadership development activities on a regular basis	Intention					
I would like to have had more management/leadership training during undergraduate training	Intention					
I will seek additional leadership/management training in my further studies	Intention					
I plan to set aside time and resources to engage in activities that help me become a better leader	Intention					
I have a personal development plan for my leadership skills outlining which activities I will engage in for the next 3 months	Intention					

Section 4: Leader Development Exposure and Relevance

Frequency of Exposure

Questions 4.1 For each of the following approaches select the extent to which you have participated in it as part of your leadership development	Not participated in this at all	Rarely participated	Occasionally participated	Moderately a feature of my development	Primary activity for my development
1. **COACHING**: Having a formal coach in or outside your organisation with whom you have regular one-on-one discussions about your leadership challenges and helping you figure out the solutions to those challenges while also holding you accountable to commitments you make. 2. **MENTORSHIP**: Having a role model or senior leader who inspires you and provides guidance on how to approach leadership challenges. One who shows you the way based on their own experience in leadership or in your field. 3. **FEEDBACK**: Having feedback from your supervisors, peers and subordinates about your leadership, performance and especially soft-skills. This includes regular one-on-one feedback, candid performance appraisals and 360-degree feedback assessments. 4. **EXPERIENTIAL LEARNING**: This includes learning by doing and figuring it out through practice. It also includes having stretching work or additional responsibility given to you such as acting in a superior role, or taking on new and complex assignments. 5. **E-LEARNING**: This includes learning leadership from social media influencers, webinars, webcasts and free online leadership skills courses (massive open online courses--MOOCs) offered by universities and leadership institutes. 6. **FORMAL LEADERSHIP TRAINING**: This includes any postgraduate training course in leadership or its constituent skills. It may be a short certificate course, diploma-level course or masters course such as the MBA 7. **NETWORKING**: This includes attending leadership forums, networking events and conferences to interact with and learn from senior leaders in your field. 8. **LEADERSHIP ROLES**: Having had leadership responsibilities outside of work, over the course of life in primary school, high school, university or community. Leadership roles may have been in sports, student affairs, religious fellowships, social clubs, class/faculty representation, politics, or community leadership.					

9. **SELF-DIRECTED LEARNING:** This includes activities such as reading books on leadership, watching leadership videos, listening to podcasts, personal reflection and journaling, and attending continuous professional development events 10. **SELF-AWARENESS:** This includes taking personality assessments and psychometric tests and learning about your leadership style, how you interact with others and the impact that has on others.					

4.2 Effectiveness/ Impactfulness of Approach to Leaders

Questions 4.2 For each of the following approaches, select how effective/impactful it is in developing leadership skills among leaders in your field	Not at all impactful	Slightly impactful	Moderately impactful	Very impactful	Extremely impactful
1. Coaching 2. Mentorship 3. Feedback 4. Experiential Learning 5. E-Learning 6. Formal Leadership Training 7. Networking 8. Leadership roles 9. Self-directed learning 10. Self-awareness					

Appendix 5—Coding book

Leader Development among Natural Scientists—Codebook

Nodes

Name	Description	Files	References
Attitude	Intrapersonal and cognitive conceptions about leadership, leader development and contextual influences that relate to one’s interest or not and motivation in participating in leadership development	17	53
Scientist Mindset	The way scientists think and have been conditioned to think and how that influences their approach to leader development	14	35
Contextual Influences	Aspects about the environment, industry, profession and country including the social-economic context, that have an implication on whether someone participates in leadership development or not	22	160
Hierarchical Structure	The hierarchical nature of the leadership structure and style depicting how lower ranks are expected to follow the direction of the higher ranks in an influence process often devoid of collaboration and consensus	8	17
Power distance	The extent to which lower level ranks accept that higher ranking officers have a right to exercise power over them	4	5
Industry Experience	A participant’s experience with the scientist world or their specific profession and how it relates to leader development or leadership effectiveness	6	6
Organisational Culture	Written or unwritten expressions of policy and behaviour that makes it easier or more difficult for a leader to engage in leader development or to be more effective at leadership	15	53
Learning Transfer Environment	The setting within which leaders practice what they are learning from a leader	2	3

Name	Description	Files	References
	development activity once they return to their day-to-day roles and responsibilities		
Outcome expectations	The perceived benefits of undertaking leader development such as promotion or enhanced ability to perform better. Also includes the perceived efficacy of leader development activities	9	20
Promotion into incompetence	The phenomenon where the highest ranking technical officer is elevated into management and leadership, away from their technical expertise into leadership and administration—an area that they might be ill equipped to handle	9	11
Social-identity	The perceptions that scientists have about themselves and their superior characteristics and how they affect participation in leader development	12	21
Societal Expectations	Formal or informal expectations put on the leader as a member of society or the group they belong to e.g., as an engineer or doctor and how such expectations affect leader development and the implicit theory of leadership	4	6
Technical Demands	Aspects about the role on the technical skills and the nature of how elevated technical skills are that makes it difficult to make time for developing soft-skills or leadership skills	9	14
Experiences and Practices	Lifespan experiences and activities that are not typical leader development activities but are reasonably believed to contribute to leadership skills development	14	29
Lifespan experiences	The sum total of activities that leaders have undertaken over the course of life that they attribute to having enhanced their leadership skills in some way	14	29
Intention	A participant's active plan and desire to engage in leader development activities	1	1
Leader characteristics	Unique aspects of the leader that have a bearing on leader development or leadership effective, such as birth order, IQ, early childhood experiences, and leader identity	17	44
Ambition	The leaders drive to be more and do more and to be part of a bigger cause and how that motivates them or encourages them to participate in activities that inadvertently develop their leadership skills	5	7

Name	Description	Files	References
Leader Identity	How the respondent identifies themselves as a leader or the trajectory of how their self-perception as a leader has emerged—including their childhood or lifespan recount of how they became a leader	6	9
Leader Development Approaches	Structured forms of activities that individuals take to develop their leadership skills	23	271
After Action Review	A pause and reflect process to examine a previous activity to identify best practices and draw lessons necessary for better performance in similar future activities	6	7
Challenging work	A developmental window that provides an opportunity for the leader to engage in solving difficult problems or making difficult decisions in an area where they do not have much experience	7	8
Coaching	Having a formal coach in or outside one's organisation with whom they have regular one-on-one discussions about leadership challenges and helping the leader figure out the solutions to those challenges while also holding such a leader accountable to commitments they have made	9	11
E-learning	This includes learning leadership from social media influencers, webinars, webcasts and online leadership skills courses (massive open online courses--MOOCs) offered by universities and leadership institutes	7	8
Experiential Learning	This includes learning by doing and figuring it out through practice. It also includes having stretching work or additional responsibility given to the leader such as acting in a superior role or taking on new and complex assignments.	14	26
Feedback	Having feedback from one's supervisors, peers and subordinates about their leadership, performance and especially soft-skills. This includes regular one-on-one feedback, candid performance appraisals and 360-degree feedback assessments.	16	27
Formal Leadership Training	This includes any postgraduate training course in leadership or its constituent skills. It may be a short certificate course, diploma-level course or masters course such as the MBA. It also includes formal structured workshops on leadership, organized by one's organisation.	14	29

Name	Description	Files	References
Leadership development programmes	Formal initiatives established by L&D teams in the organisation that combine multiple leader development approaches as a way of nurturing leadership skills	10	20
Leadership Roles	Having had leadership responsibilities outside of work, over the course of life in primary school, high school, university or community. Leadership roles may have been in sports, student affairs, religious fellowships, social clubs, class/faculty representation, politics, or community leadership.	12	24
Mentorship	Having a role model or senior leader who inspires an individual and provides guidance on how to approach leadership challenges. One who shows the way based on their own experience in leadership, profession or industry	21	50
Networking	This includes attending leadership forums, networking events and conferences to interact with and learn from senior leaders in one's field.	5	8
Self-Awareness	This includes taking personality assessments and psychometric tests and learning about one's leadership style, how they interact with others and the impact that has on others and consequently the leader's effectiveness	11	16
Self-directed Learning	This includes activities such as reading books on leadership, watching leadership videos, listening to podcasts, personal reflection and journaling, and attending continuous professional development events	13	17
Undergraduate Training	The experience of learning leadership skills at undergraduate level	11	19
Leader self-efficacy	The personal belief and conviction in one's ability to be or not to be a leader	3	3
Leadership Effectiveness	The extent to which a leader demonstrates the leadership skills and behaviours required to meet team and organisational performance goals	18	59
Critical Skills Required	The essential skills that leaders require to be effective	18	59
Communications	The oral and written skills that elevate one's ability to pass on information in ways that connects with, persuades and inspires others	5	7
Conflict Resolution	The leader's ability to mine for conflict in the team early and manage it properly	3	3

Name	Description	Files	References
Delegation	The ability for the leader to develop and empower teams to effectively act on their behalf and deliver an equally good job without the leader having to personally and directly be involved	1	2
Politics and Diplomacy	The leaders' skills in adapting and connecting with others, lobbying, building networks and coalitions and building up their influence to negotiate what they desire	4	9
Service Orientation	The leader's attitude towards serving others and demonstrating customer service skills	2	4
Perceived Behaviour control	Perceptions and beliefs expressed by the respondent about their context that make them believe that participating in leader development is within their control or not. This code relates to locus of control and the individual's perceptions about how their context makes it easier to engage in leader development	3	3
Subjective Norms	Narratives and stories that are perpetuated among scientists or non-scientist groups as the typical behaviour, values or beliefs and are therefore imposed on group members by expectations	5	6

Appendix 6—Gatekeeper letters

respondence on
ct please quote No. **FAD 46/317/02**

THE REPUBLIC OF UGANDA

MINISTRY OF AGRICULTURE,
ANIMAL INDUSTRY AND FISHERIES
P.O BOX 102,
ENTEBBE, UGANDA
E-MAIL: ps@agriculture.go.ug
WEBSITE: www.agriculture.go.ug
TELEPHONE: 256-414-531411-135/255-137
FAX: 256-414-255-183/255-184

5th November 2019

Mr. Lukwago Julius
University of KwaZulu- Natal, Westville Campus
SOUTH AFRICA

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT MAAIF

Reference is made to your letter dated 23rd October 2019, on the above subject.

The purpose of this letter is to inform you that, permission to conduct research at the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) has been granted.

You will be expected to share your research findings and report with this Ministry.

[redacted]

For: PERMANENT SECRETARY

Uganda Revenue Authority
DEVELOPING UGANDA TOGETHER

Head Office: Plot M193/M194 Nakawa Industrial Area
P.O.Box 7279, Kampala Uganda
Tel: +256417442097
Fax: +256414334419
Toll Free: 0800117000
Email: info@ura.go.ug

URA/HRM/3.13.1

October 17, 2019

Julius Lukwago
C/O University of KwaZulu-Natal
Graduate School of Business and Leadership,
SOUTH AFRICA,

Dear Sir,

LETTER OF OFFER

Please refer to your request to carry out research on the topic: **"Leader development practices that engender leadership effectiveness among natural scientists in Uganda: a comparative study."**

This is to inform you that your request has been granted on the following terms:
a) Your data collection period shall not exceed six months. If you require more time, then you shall formally request the Assistant Commissioner Human Resources.
b) You will also avail a copy of research results in a bound book to the Manager Human Resource Development after completion of research.
c) You will sign an oath of secrecy to maintain confidentiality of information received in the course of the research.

Your research will be supported by the heads of station where you will issue questionnares, carry out interviews and you are obliged to follow their guidance on the logistics in order not to disrupt ongoing work.

I wish you success in your endeavours.

Yours faithfully

[redacted]

Blenda Nakkazi
Ag.MANAGER HUMAN RESOURCE DEVELOPMENT

Appendix 7—Ethical clearance

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

21 August 2021

Mr Julius Lukwago (217080895)
Grad School Of Bus & Leadership
Westville Campus

Dear Mr Lukwago,

Protocol reference number: HSSREC/00000933/2020
Project title: Leader development approaches that engender leadership effectiveness among natural scientists in Uganda a comparative study
Amended title: Leader development approaches that engender leadership effectiveness among natural scientists in Uganda - a comparative study

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 10 August 2021 has now been approved as follows:

- Change in title

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

Best wishes for the successful completion of your research protocol.

Yours faithfully

[redacted]

....

Professor Dipane Hlalele (Chair)

/dd

Humanities & Social Sciences Research Ethics Committee
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Tel: +27 31 260 8350 / 4557 / 3587
Website: http://research.ukzn.ac.za/Research-Ethics/

Founding Campuses: Edgewood | Howard College | Medical School | Pietermaritzburg | Westville

INSPIRING GREATNESS

15 June 2020

Mr Julius Lukwago (217080895)
Graduate School of Business & Leadership
Westville Campus

Dear Mr Lukwago,

Protocol reference number: HSSREC/00000933/2020
Project title: Leader development approaches that engender leadership effectiveness among natural scientists in Uganda a comparative study
Degree: PhD

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 25 May 2020 has now been approved as follows:

- Change in Research Methodology (using Zoom, Skype, MS Teams, WhatsApp and telephone due to COVID-19)

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

This approval is valid for one year until 16 January 2021.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

Yours sincerely,

[redacted]

Professor Dipane J Hlalele (Chair)

/ms

Humanities & Social Sciences Research Ethics Committee
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Tel: +27 31 260 8350 / 4557 / 3587
Website: http://research.ukzn.ac.za/Research-Ethics/

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

16 January 2020

Mr Julius Lukwago (217080895)
Graduate School of Business & Leadership
Westville Campus

Dear Mr Lukwago,

Protocol reference number: HSSREC/00000933/2020
Project title: Leader development approaches that engender leadership effectiveness among natural scientists in Uganda a comparative study
Degree: PhD

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 09 January 2020 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid for one year until 16 January 2021.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

Yours sincerely,

[redacted]

Professor Urmila Bob
University Dean of Research

/ms

Humanities & Social Sciences Research Ethics Committee
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Tel: +27 31 260 8350 / 4557 / 3587
Website: http://research.ukzn.ac.za/Research-Ethics/

Appendix 8—Turnitin similarity report

Final Thesis

ORIGINALITY REPORT

4%	3%	1%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS