ICFTE
2nd INTERNATIONAL CONFERENCE ON FUTURE OF TEACHING & EDUCATION
Munich,Germany
6 - 8 December,2019

Contributions of interpersonal and intrapersonal factors to the career decision-making behaviour of STEM Students in South Africa

Abe, Ethel Ndidiamaka, Chikoko, Vitallis[2, *] and Abe, Isaac Idowu[3]

[1, 2] School of Education, University of KwaZulu-Natal, Durban, South Africa

[3]Cape Peninsula University of Technology, Capetown, South Africa

Abstract.

The purpose of this study was to provide a well-defined hypothetical context and corresponding empirical proof for connecting physiological and mental factors to individual learner's decision to pursue a career in science, technology, engineering and mathematics (STEM) at a South African university. Concerted efforts by stakeholders in STEM to increase enrolment decisions by university students have somehow been unable to fully address the demand for skilled STEM workforce in South Africa. This has heightened the need to understand the challenges and factors that influence learner's career decisions. A qualitative research method involving a descriptive survey was adopted for this study and the Social Cognitive Career Theory (SCCT) was used as a theoretical framework. The data was collected from undergraduate STEM students. The QSR International's NVivo 12 software was used to organise data for ease of content analysis. The results suggested that three categories of variables namely 1) interpersonal factors e.g., family and teachers, 2) intrapersonal factors e.g., champion mentality, career interest in STEM, personality, personal development, self-efficacy and spirituality, and 3) career outcomes expectancy factors e.g., finance, and career opportunities and prospects, contributed significantly to the students' career decision-making. Unexpectedly, peer influence was completely absent; this finding is inconsistent with extant literature. The use of SCCT as a lens to study career decision making behaviour of STEM students was strongly supported.

Keywords: Career decision-making, family influence, outcome expectancy, personality typology, social cognitive career theory.

Introduction

South Africa ranks among the top nations globally to spend a large amount of her national resources on education with respect to percentage gross domestic product (GDP) (Van der Berg & Burger, 2003). Practically, government and stakeholders in STEM education try to grow sustainable decisions in STEM among students through the provision of funding from the National Student Financial Aid Scheme (NSFAS) and other supportive initiatives (Manuel, 2019). The NSFAS funding through a *ring-fenced system*, only provided for learning materials. However, a recent change in its ring-fenced policy to outright cash transfers seems to have

resulted in a notable student drop in the rate of textbook purchase and decline in the academic performance of. A non-profit organisation called the Alliance for Academic Success cautions that most beneficiaries of the monetary disbursements are using the funds to address family challenges instead of their academic needs (Duma, 2019).

Unfortunately, South Africa was among the four lowest performing nations in STEM at the tertiary level in Sub-Saharan Africa between 2011 and 2015 (Tikly, Joubert, Barrett, Bainton, Cameron, & Doyle, 2018), with *'only 1 in 10'* high school students deciding to pursue a career in STEM at tertiary levels (Planet Earth Institute, 2016). Furthermore, high attrition and low performance among enrolled STEM students is frequently documented (Prince, 2017). Therefore, additional high school and university programmes have been developed to further motivate students to choose STEM courses (Kirby & Dempster, 2018; Tikly et al., 2018). Although some of these endeavors have been helpful, career decision-making still poses challenges among students (Fogarty & McGregor-Bayne, 2008).

1.1 Literature review

Global literature is rich in empirical evidence about the factors influencing career decision-making, some of which are family influence, passion, capacity, self-efficacy, apparent difficulty, values, gender and race (Bieri, Berweger, Keck & Kappler, 2014; Watt & Eccles, 2008; Lent, Brown, Sheu, Schmidt, Brenner, & Gloster, 2005). The bulk of attention for the past two decades has been on investigating career decision-making in STEM in western countries. However, there is potential in examining how the available theoretical frames could be tailored to the South African context.

1.1.1 Interpersonal factors

We reviewed the literature on the extent to which family members, teachers, and peers influence STEM students' career decision-making.

The decision to pursue a career in STEM associates with parental influence. Bandura (1977) asserts that families, educators, and peers are vitally influential in the enhancement of self-efficacy beliefs. Studies have established that self-efficacy could be developed when families and educators accentuate the significance and worth of career proficiencies (Bandura, Barbaranelli, Caprara, & Postorelli, 2001). The influence of family support and attitudes to STEM have been operationalised in several ways, for example, the development of SCCT to incorporate social-contextual factors (Lent, Lopez, Lopez, & Sheu, 2008). Workman (2015) confirms that parental influence was dominant among the themes in learner decision making processes. This claim is confirmed by several other scholars (Nugent et al., 2015). Jacobs, Chhin and Bleeker (2006) report that the girl learner's self-perceptions and proficiencies were influenced by parental gender labelling and encouraged gender-typed career choices. This could be responsible for the under participation of the female gender in STEM as reported globally (Tikly et al., 2018; Wang & Degol, 2017; Hartung, Porfeli, & Vondracek, 2005).

However, a teacher's support is important in promoting career decision in STEM. Studies have shown that educators have a strong influence on learner decision (Clotfelter, Ladd & Vigdor, 2007; Rivkin, Hanushek, & Kain, 2005). Likewise, the attitudes of students' peers, their accomplishments, and standards can wield a sharp influence on young people's interest for choosing and deciding to study a specific course (Olitsky, Loman, Gardner, & Billiups, 2010). The period of growing up is a time of acquiring a personality and sense of self, and

during this period, peers can be very instrumental in guiding each other's choices, behaviours, and career interests (Vedder-Weiss, & Fortus, 2013).

1.1.2 Intrapersonal factors

These comprise of factors influencing students' whole intrinsic experiences to pursue a creer in STEM and their desire to achieve career outcome expectations.

Career decision-making comprises several domains and complex processes. Gelatt's (1962) progressive decision-making model offers a supporting foundation for comprehending how career decisions are made. The model shows the process of decision making as on-going activity that changes dynamically with the acquisition of additional information. For instance, a young learner who is exposed to technological tools used by their father could learn how to use them and decide over time to choose a career in technology. Furthering the view of Gelatt (1962), Niles, Amundson, and Neault (2010) propose that adolescents are pre-emptive catalysts of the socio-cultural domain. Hence, they dynamically integrate knowledge and texts from others to ultimately develop a repository of decision-making.

Outcome expectancy is one of the major constructs that inform career decision. It involves the perceived outcomes of performing specific actions (i.e. 'if I do this, what will happen?'). The construct assesses young peoples' perception of several professions based on their apparent economic, shared, and self-satisfaction outcomes. In SCCT, career outcome expectancy is positioned as a key mediator of profession and scholarly interest and skill advancement (Nugent, Barker, Welch, Grandgenett, Wu, & Nelson, 2015). In addition, there are empirical proofs that outcomes expectancy is central in predicting intentions to pursue a career (Fouad & Smith, 1996).

Another construct, the career interest, is a predictor of both career preference and outcome (Nugent et al., 2015). Scholars found that career interest is positively connected to decisions to enrol in a field (Dabney, Tai, Almarode, Miller-Friedmann, Sonnert, Sadler, & Hazari, 2012; Hulleman, Durik, Schweigert, & Harackiewiez, 2008). Students who show interest in STEM early in life often decide to study STEM ultimately (Organisation for Economic Co-operation and Development, 2005).

Furthermore, self-efficacy has been examined as a predictor of career interest using SCCT theories (Fouad & Smith, 1996; Lent, Brown, & Hackett, 1994). Personal factors and practical STEM-related behaviours influence the formation of self-efficacy, interests, and values, which impact decisions in STEM (Tate, Fouad, Marks, Young, Guzman, & Williams, 2015; Jacobs, Davis-Kean, Bleeker, Eccles, & Malanchuk, 2005). Eccles and her associates propose that educators, peers, and families are well positioned to create prospects for students to participate in several STEM-associated activities via learning experiences and special courses (Wang & Eccles, 2012; Eccles, Wigfield, & Schiefele, 1997).

The role of personality in career decision-making behaviour is well researched (Sullivan & Hansen, 2004; Seibert & Kraimer, 2001; Holland 1997, 1959). Holland (1959) proposed a theory suggesting that an individual's career interest expresses their personality. The theory suggested that personality is a combination of several factors comprising capabilities, interests, behaviours, and principles. Holland (1959) confirms that where an individual's career decision agrees with this combination of factors, then there is congruence between the individual and the environment. He categorised individual personalities into six types, namely *Realistic*, *Investigative*, *Artistic*, *Social*, *Entrepreneurial* and *Conventional* (RIASEC). This

categorisation is based on the conviction that an individual's experience in the environment of his/her upbringing creates the inclination towards specific interests or behaviours. With six adjectives, Holland (1959) characterised individual personalities to portray passions, capabilities, principles and behaviours related to them. For example, an investigative individual will possibly be accurate, systematic, inquisitive and intelligent. Researches that used this personality typology often supported the theory that an individual learner's personality influenced their decision to pursue a career in a study area. For instance, Pike (2006) found that students' personality influenced their career outcomes expectations and resultantly career decisions. According to Chen and Simpson (2015), students that are very exploratory or have a highly investigative personality, would often decide to pursue a career in STEM.

1.1.3 Theoretical framework

A refined theoretical position, the SCCT (Lent, Brown, & Hackett, 1994), and Holland's (1959) personality typology surfaced in the literature as effective theoretical frameworks with which career decision-making in recent contexts could be investigated. This study seeks to hinge its findings within these reputable frameworks. The overarching aim of the study was to investigate the influence of family and personality on the decision to pursue a career in STEM in a South African context. This literature review provides a foundation for conducting a clearly defined research among STEM students in a South African University.

Lent et al's., (1994) SCCT, which is based on Bandura's (1986) Social Cognitive Theory, investigates the way that belief in self-abilities works in a system of socio-cultural and socio-economic contexts to influence career decision-making conduct. The concept confirms that a personal career decision is derived from mutual associations among social cognitive processes of self-efficacy, outcome expectations and goal setting conduct (Bandura, 1986; Lent et al., 1994). These social reasoning processes could be influenced by external forces, for example, difference in backgrounds. SCCT is recognised and extensively applied in STEM education research. Paulsen, Cardella, Jones and Wolsky (2015) found that young people's informal knowledge about engineering influenced their interest in and decision to pursue a career in engineering. Other scholars have used SCCT to prove that self-efficacy is very influential in female students' decision to pursue a career in STEM at tertiary education levels (Pajares & Valiante, 2001; Lent et al., 1994). Self-efficacy and career decisions outcome expectancy together assist students in evaluating the future outcomes of their chosen careers and in setting goals (Zimmerman, 2013). Tai, Liu, Maltese and Fan (2006), provide evidence that self-efficacy and optimistic career outcome expectancy significantly influence the decision to pursue a career in STEM.

Generally, the constructs examined above have all been identified as influential in career decision making. The fit among perceived personality and career decision was examined in this study based on Holland's (1959) RIASEC model. SCCT was used in exploring the influence of external factors on STEM students career decision making in the university examined.

2. Methods

A qualitative research method involving a descriptive survey was adopted for this study. Mugenda and Mugenda (2003) recommend that researchers planning to explore, define, clarify and explain gathered data in a specific context should preferably use a qualitative research method. To achieve this, Holland (1959) RIASEC personality typology and SCCT (Lent et al. 1994) guided the collection of qualitative data with an explorative intention. We deduced the significance of issues from participant's narratives concerning the subject of mutual interest. Constructivist theory permits the gathering of data, analysis of collected data and theory to share mutual associations with one another (Strauss & Corbin, 1990).

The survey was placed online on the university's official website along with a letter of informed consent. Data was collected over a six-month period. Each respondent signed the informed agreement. Target population was 2000 undergraduate STEM students out of which a sample of 322 based on Krejcie and Morgan's (1970) table for determining sample size. We took cognisance of the association between data and theory in using convenient sampling and open-ended questions in the collection of data. Piansoongnern and Anurit (2010) suggest that open-ended interviews assist researchers to gather facts, get understanding of respondents' views and knowledge as well as determine the examined phenomenon's actual processes. In this study, data elicited from the open-ended interviews (Turner III 2010; Gall, Gall, & Borg, 2003) was authenticated to augment the integrity of the findings. This was achieved by engaging two experienced researchers in the subject area who coded the data and conducted the essential comparisons.

Feedback from two hundred and three (203) students was received however 53 were found unusable due to data saturation; no new information could be obtained. The used responses were numbered to further strengthen anonymity. Exact statements are also presented to validate the groups of themes. The statements in some cases mirror a *pool* level of English grammar because the English language is not the first or second language spoken by some of the respondents in this study.

2.1 Results

2.1.1 Demographic data

The findings of this study show that out of the 203 respondents, 115 (representing 56.7% of the total responses) were female students while the male students were 88 (43.3%) in number. With regards to racial background, we found that majority of the respondents totalling 146 (71.9%) were from the Black race, while Indians, Whites, and Colored races represented 22.7%, 3.0% and 1.0% respectively of the respondents. In addition, the findings about the environment of the respondents' upbringing showed that 84 (41.4%) were raised in the urban areas, 78 (36.0%) in the rural areas, and 46 (22.7%) were raised in the semi-urban areas. Rural areas were described as settlements located outside towns and cities with few homes or other buildings, and not very many people. Semi-Urban areas referred to areas that are somewhat urban and somewhat rural, while urban areas were very developed, densely populated with humans, houses, commercial buildings, and road networks.

2.1.2 Factors influencing career decisions

Respondents' responses regarding their opinions about the factors that influenced their decision to pursue a career in STEM are presented in Figure 1 (please see the appendix). Three themes emerged and were classified as interpersonal factors, intrapersonal factors and career outcomes expectancy respectively. In each theme rests several sub-thematic experiences, interweaving the students' narratives together into a common mesh. Sub-themes included the interpersonal factors that developed prior to enrolment at the university. Intrapersonal sub-themes concentrated on students' whole intrinsic experiences as undergraduate students and their desire to achieve career outcome expectations. Career outcome expectancy sub-themes discussed financial matters and opportunities and prospects that contributed to founding students' career decisions. Although family influence and personality served as the focus of this study, unexpected sub-themes of parental need for support, spirituality and financial matters arose. These sub-themes were categorised appropriately as shown in Figure 1 below.

Figure 1 Factors influencing decision to pursue career in STEM

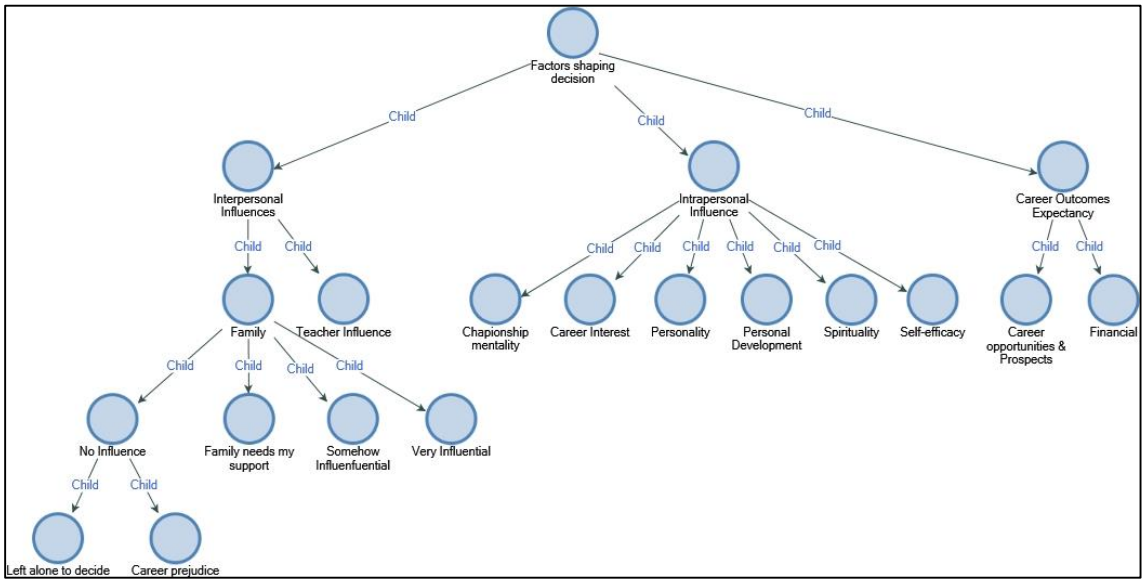

Fig.1 was created with QSR NVivo12 Software.

The details about these themes are explained respectively.

Theme 1: Interpersonal influences

Family Influence: The first category under theme one showcases the type of influence that family has on STEM students' decision to pursue a career in the STEM field. The students' perception of their families' influence on their decision to study STEM are summarily described as: *'very influential', 'somehow influential', 'no influence',* and '*family needs my support'*. The responses captured under the 'no-influence' subcategory was further grouped into '*career prejudice'* and *left alone to decide'*. The use of these adjectives does not in any way carry measurable significance but are only explanatory of the meaning of the content derived from respondents' responses.

Most of the students felt that their families were *very influential* in their decision to pursue a career in STEM as shown below:

"My family has a huge positive influence because in my family they've advised me that in the field of STEM there are lot of good opportunities as well as life itself as we use technology in our daily basis."

"My late mom actually played a big role, and I wanted to be more like her."

"My family encouraged me to enrol for STEM and has supported me 100% in my study choices and I personally enjoy STEM related fields, this has pushed me to achieve great academic success."

"My family influenced me a lot, everyone in the family believe in STEM, I also think STEM is the future."

"My family has shown me what to expect in different STEM fields. They also showed me what careers might be good for my personality."

"My current career was greatly influenced by the fact that my late uncle used to hire me to work with him part time on his Engineering related business."

"They have a great influence, they even told how it is going to benefit me when I am done studying and how great it is."

(Respondents 10, 12, 19, 21, 24, 52, 53)

Many students in this study perceived their parents as being strong positive influences in their career decision to study STEM. However, there were several others who believed that their families were *somehow influential* but the final decision to study STEM was made by them. They reported as follows:

"My family has been somewhat influential in me having a career and being independent. I am very determined to change my way lifestyle, therefore am willing to work hard in my chosen field."

"I have reached a point where my family is much caring about pursuing my chosen field, they encourage me not to give up but try to tolerate every situation comes across to fulfil my potential desires."

"I'm the only one who have a qualification at home, I get more encouragement to study from them. I was raised by a farm worker so pursuing studies under STEM is something I grew up wishing although less support from them because they are not educated."

(Respondents 3, 7 and 15)

These students felt that their families played supportive roles in their decision to pursue STEM careers. However, there are innuendos suggestive that some students made their decision without family interference or that the family suggested a course different from the learner's choice and subsequently accepted to support the student's decision.

Yet, a worrisome sub-theme emerged where some students felt that they were under obligation to support their family. This trend could be referred to as an inverse influence on students' decision. The responses of some of the students in this sub-theme - f*amily needs my support* are as follows:

"I tend to take career decisions based on how urgent my family needs support. it hasn't paid off so far, but it does have an impact on my decision making".

"They are very happy because they know that by being under STEM may lead to many job opportunities to help"

"My family just wants me to have a career that will guarantee a good lifestyle at the end. When you are born under privileged, you are not satisfied by life. Hence, you always believe you have to be successful at what you do, even if it is a career within STEM in order to support the family".

(Respondents 2, 58, and 83)

Notably, most respondents in this study come from erstwhile marginalised backgrounds (please see Table 3 in the appendix) where the influence of family on career decisions is not obtained because of the structure of the family. For instance, a learner from a child-headed or poor family where both parents are not educated may be influenced by the need to change the status of the family. While others could, as a result of funding available to STEM students, decide to pursue a career in this field.

Conversely, there were several students whose families made no contribution to their decision to study STEM. Expectedly, these students felt negatively about family influence on their career decision. They reported that their family had *no influence* over their career decision hence, they were *left alone to decide:*

"My parents are not educated, so they supported and appreciated that I wanted to continue studying after Grade 12 as to what field I chose they had no influence at all."

"My family has no influence whatsoever on my decision to study STEM."

"My family doesn't contribute that much in my life, so I make all the decisions by myself"

"My family pretty much doesn't care about what I do, as long as I'm studying."

"My family they do not care what studies I take the only thing they want is to see me happy in what I do and study."

"My family doesn't affect that much about making decisions I only have a say to what I want to learn, and I should be the one knowing about the outcomes of my learning."

"My family members are mostly uneducated therefore my decision will not be influenced with anything that they may want to say."

(Respondents 22, 40, 42, 62, 64, 65, 147)

Although most of these students' families seem not to have any influence on their decision, none of them came across as predominantly worried with the lack of family influence; it just did not appear to be a huge factor in their lives. Further understanding of the intricacies of family influence in the career decision behaviour of STEM students in this university could yield meaningful results.

Likewise, *career prejudice* emerged in this category explicating why family had no influence on the decision-making behaviour of some students. These students said:

"They sometimes have prejudice about my career because of my gender."

"STEM includes my area of academic learning. I am studying Engineering. My family believes that if you choose a career in STEM, you might never finish your studies because it is difficult." (Respondents 13 and 45)

These students believed that their families were prejudiced against their decision to follow a career in STEM. This stems from people in families who seem to think that a career in STEM is gender sensitive. This bias could be adversely influential on female students' decision

to pursue a career in STEM. Many other reasons beyond this study could contribute to career prejudice.

Teacher Influence: This second category of theme one (interpersonal influence) showcases the influence that teachers have on career decision making behaviour of STEM students. Some responses were:

> "Well during my high school days I taught myself but influence from my teacher made me more interested in STEM As for family they had no idea what I'm doing, all they wanted was me to be successful and that all"
>
> "To a good extent, choosing a science stream as advised by my teacher in high school propelled me to do science related careers which I enjoy the most".
>
> (Respondents 57 and 107)

Some respondents felt that their high school teachers played important roles in their decision to pursue a career in STEM. Teachers could easily identify and encourage talented students in science related modules and mathematics in the career-decision making process.

Theme 2: Intrapersonal Influences

'Champion' mentality: The first category under theme two is what is titled 'champion' mindset. Individuals with champion mentality often want to 'save' or 'change' the world. The word was merely chosen to summarily capture the content of the responses of the respondents in this category:

> **"**STEM is most effective way in fast development of our country, since we need more people in STEM related field in South Africa to quickly grow our economy and have a much broad experience in our own to benefit the country and the world at large, I decided to choose a career in STEM."
>
> "In my family, we've never had an Engineer, so If complete my studies, I'll be the first engineer in my family and surely I will make a difference and my family will be really proud."
>
> **"**Engineering seemed like a fun major and that it can lead to great things by helping people."
>
> **"**To become one of the scientists in the world and be able to improve the living of people in the world using different skills in science."
>
> **"**My family and personal traits influenced me a lot as in the world we are living in families are viewed as inferior or people who won't do science, so I wanted to prove to the world that I can."
>
> (Respondents 18, 25, 29, 126, 142)

Commonly most respondents in this category desire to make a difference in their family and/or society. They believe strongly that by pursuing a career in STEM they would be changing their family's status or helping society at large.

Career Interest in STEM: This is the second category under theme two. Interestingly, most students' decision to pursue a career in STEM was based on their career interest.

> **"**My personal interest in this career influenced my decision to study STEM to a great extent."
>
> **"**I'm passionate about the field of science."
>
> **"**I've always loved science, especially biology. My parents always encouraged me to pursue a career I am passionate about."

"Passion and curiosity for the environment attracted me to science."

"I have always been curious and enjoyed STEM."

"I have always loved nature and what makes it, hence i have always enjoyed biology."

"My decision to study STEM was influenced more by my own interests and my traits than my family."

"I've always had a passion for helping other people and a fascination for the human body and this influenced my decision to choose a degree in health sciences."

"I am interested in evolving things, research and innovations. This encouraged me towards STEM field."

(Respondents 17, 78, 84, 85, 106, 113, 117, 133)

Many respondents' passion, dreams, aspirations, desire and curiosity to study a career in STEM were highlighted in their responses. Career interest is important in the decision-making process of students and has implication for policy decisions.

Personality: This is the third category of factors influencing career decision as found in theme two. This term is used purely as a descriptive presentation of interpretations of individual student's person, reasoning or aptitude deducted from their feedback.

"No one other than myself who has the say in my life influences and to what I decide on doing."

"it's certainly only personal traits that influenced my career choice and decision."

"My inquisitive approach to life at large and my family supportive nature on supporting my journey in obtaining such information."

"Individual traits: my (particular sort of) intelligence and manner of thinking resulted in an affinity for mathematics and physics."

"I am a very logical thinker and naturally very curious. These traits lead me to study STEM and also makes learning easier as I am interested in what I'm learning."

"I think my critical reasoning skills are the pain driver towards STEM."

(Respondents 49, 50, 54, 75, 90, 96)

Most respondents identified their personality as being influential in their decision-making behaviour. Recognising the role of one's personality in their decision-making process is critical to successful engagements and achievements in a career. These views may have been influenced by respondents' experiences as science and mathematics students in high school and reflect their perceptions of their career decision-making behaviour.

Personal development: The fourth category of factors identified in theme two is personal development. Several students desire to develop themselves with knowledge, and skill attributed to STEM fields underpinned their decision to pursue a career in STEM.

"STEM is incorporated in our everyday lives, pouring a litre of milk, baking a cake to sell to make a living, providing electricity for households. It is nice to know what goes on in the smaller parts of life which become the greater ones. I love learning about all that in order to improve the lives of others and mine."

"To keep myself updated with new and incoming technology."

"I like to be challenged so that's why choose a course in STEM which is a challenging course to bring out my potential."

(Respondents 35, 59, 80)

These students thought that a career in STEM would challenge and develop their potentials. Students whose decision to pursue a career in STEM on this basis could achieve meaningful success and complete their study in record time.

Self-efficacy: This is the fifth category of concepts under theme two. Self-efficacy is the confident belief in one's self about one's ability to achieve goals and it develops from earlier experiences and verbal persuasions attributable to the environment of upbringing.

> "I believe in me. Being in harmony with my family and with myself, I've known to accept my strengths and weaknesses and through assessing those, I know I wouldn't want to study anything else. And accepting that I'm studying what I believe I was born to do, makes me appreciate more and work harder."
>
> "Family satisfaction makes for a motivating environment which allows me to grow and believe in myself during my studying journey."
>
> "My family believes in me, I believe and know that I can succeed in almost everything that I set my mind into, which is why I went to science even though it wasn't my first or even second option. I'm doing well my results are good."
>
> (Respondents 33, 79, 121)

Some respondents appeared to believe that they could be successful in a career in STEM. They seemed to understand what they could do.

Spirituality: This is the sixth concept in the category of factors found in theme two. respondents said:

> "I pray about all my decisions and entrust them to Jesus."
>
> "Being in the STEM requires one to be in tune with their moral and spiritual values more than financial needs."
>
> (Respondent 87 and 108)

Few respondents seemed to believe that they were influenced by their spiritual life to pursue a career in STEM, while others saw morality and values as being supreme to financial benefits deriving from a successful completion of study in STEM.

Theme 3: Career Outcomes Expectancy

Financial matters: Financial matters describe the first category of factors that emerged in theme three. We did not set out to evaluate the effect of finance on career decision- making behaviour of students in STEM, but it emerged as a theme.

> "It's a good career path and its paying well since it's a scarce skill."
>
> "I chose my career according to my ability and interests and future financial stability."
>
> "Finance greatly affected my learning decision, especially family related issues that demanded financial contribution."
>
> "I wanna be happy in what I do and be glad of my finances being able to help and support my parents in every way possible for me, so I'd be happy."
>
> (Respondents 32, 72, 99,130)

Several respondents appeared to perceive a career in STEM as economically very rewarding. Therefore, the expectation of better pay when study is completed could have stimulated their decision to pursue a career in STEM.

Career opportunities and prospects: These factors emerged as the second category of theme three factors. respondents stated thus:

"My family believes Science has more opportunities, benefits and career prospects more than other fields of study."

"STEM there are lots of job opportunities and you can get a job. Some of the jobs are similar and you can use skills from one job in the other job."

"My family had always told me about the opportunities that sciences provided, the money and also the respect for science learners."

(Respondents 134, 139 and 141)

Several respondents felt that their families understood and explained the benefits and prospects of pursuing a career in STEM to them.

2.1.3 Discussion of findings

The results of this study provided strong support for the social cognitive career theory (SCCT) proposed by Lent et al. (1994) and Holland's (1959) personality typology as meaningful frameworks to investigate career decision-making behaviour of STEM students. This is derived from the alignment of themes in the study to the underpinning factors of the theories. For instance, the three themes of influencing factors, namely interpersonal (external social factors), intrapersonal (cognitive factors) and career outcomes expectancy, align to the factors in SCCT's career decision-making model. Similarly, respondents' strong indication that their personality influenced their decision to pursue a career in STEM corroborated Holland's claim. The findings also reiterated the argument by Gelatt (1962) and Niles et al., (2010) that students dynamically integrate knowledge and texts from others to ultimately develop a repository of decision-making. This result is a meaningful contribution to the career literature.

Yet another interesting result is the finding that families were a large, mostly positive, influence on student career decision making behaviour. With this evidence, career advisors and other professionals working with yet-to-be-decided students could appreciate the role a family plays in a student's life and understand how to positively use this information. Another intriguing finding that some students made the decision to study STEM due to felt pressures to support their families was recorded in this study. There do not seem to be any studies in which such a result was found. The result of this study therefore makes meaningful theoretical contribution as it extends the SCCT model.

Bandura (1977) asserted that families, teachers and peers together influence a student's self-efficacy and career decision-making, but this study found that peer influence is literally absent among respondents. The finding is inconsistent with extant literature report on the influence of peers on career decision-making behaviour of students (Vedder-Weiss & Fortus, 2013; Wang & Eccles, 2012; Eccles et al., 1997; Eccles et al., 1993).

In addition to extant literature's abundant findings that family influence is leading among the themes in student career decision-making behaviour (Workman, 2015; Nugent et al., 2015; Jacobs et al., 2006), this study, using a qualitative approach, uniquely identified a dimensional angle to family influence. These dimensions include Dimension 1) *Family is very influential* from theme one. This finding supports the claim that family is dominant in influencing career decision behaviour (Workman, 2015) and further validates a claim by Paulsen et al., (2015) *(See Respondent 52).* In Dimension 2), family had *no influence* on the

student decision to pursue a career in STEM as reported by many respondents. It had a sub-dimension *left alone to decide* and family is *career prejudiced*, which is new in career literature. Respondents who felt that they were l*eft alone to decide* what to study explained that their parents were uneducated or unable. However, career prejudice against gender reiterates a report by Jacobs et al., (2006) on influence of gender labelling on female learners. The Dimension 3) theme - *support their families* is somehow disturbing. This finding could be meaningful in validating the unfolding information about student funding in South Africa. According to Duma (2019), some students use the NSFAS monies to support their families. Finally, Dimension 4) where family *was somewhat influential*. Family influence is complex, changing from student to student, and having sometimes contradictory influences on them. Advisors abreast of this dynamic will be able to ascertain when and if a student should discuss their decision process with their family members.

Teacher influence on STEM students' career decision is confirmed in this study as claimed by scholars (Clotfelter et al., 2007; Rivkin et al., 2005). However, peer influence is not supported. This could either be indicative of an individualistic environment favouring little or no interaction between students or explained by the high technicality of the STEM field. Ideally, peer influence in line with Bandura (1977) should have been part of the model in Figure 1, but it is not, thereby strengthening the argument for individualism among STEM students (Estrada, Eroy- Reveles, & Matsui, 2018).

In agreement with extant literature, this study found that career decision cannot be made in isolation, but interpersonal, intrapersonal and other influences must interconnect in career decision-making (Eccles et al., 1997; Eccles, 1994). Self-efficacy was identified in the literature as a predictor of career interest (Fouad & Smith, 1996; Lent et al., 1994). Self-efficacy was found in the intrapersonal theme of this study and agrees with literature on its influence on career decision-making behaviour of students (Tate et al., 2015; Jacobs et al., 2005). Additionally, early experience in engineering pre-empted a learner's interest in STEM and culminated in a decision to pursue a career in the field of STEM (OECD, 2005).

Outcomes expectancy construct measuring students' perception of some careers based on their perceived financial, societal and self-satisfaction effects (Nugent et al., 2015) is supported in this study. We found that high expectancy convictions led to students' pursuit of careers in STEM. This finding can be meaningful in designing initiatives to strengthen student career decision skills (Zimmerman, 2013; Tail et al., 2006).

On the other hand, Holland's (1959) personality categorisation is supported as an influential factor in predicting students' decision to pursue a career in STEM. Respondents reported that they were inquisitive, intelligent, curious and analytical/critical. Chen and Simpson (2015) claim that students with an investigative disposition would choose a career in STEM was also validated in this study. The findings further literature in the study of career decisions-making behaviours in STEM by identifying the influence of personality (Holland, 1959) in addition to families and teachers on students' career decision-making behaviour in a South African university.

Surprisingly, the findings on gender in this study challenged the general belief that female students were underrepresented in the STEM field (Tikly et al. 2018; Wang & Degol, 2017; Hartung et al., 2005). In the context of the university examined, more female students pursue a career in STEM thereby bringing a new insight to the career literature from the South African context.

2.1.4 Limitations

This study has two main limitations. Primarily, the open-ended interview was not designed to assess Holland's (1959) personality typology or constructs of the SCCT. However, content experts were consulted to provide some form of validity and reliability for the study. Further studies are needed to reconfirm the findings of this study in a quantitative survey. The second limitation of the present study is that data was collected from a single university, and because of this, the findings may not be generalisable to other tertiary institutions. Researchers could in the future, use data from a wider array of institutions with various student populations. However, since the data collected for this study emerged from a sizable number of a diverse student population and vast range of majors, we believe that the findings offer some important insights into the factors that influence students' decision to pursue a career in STEM.

3. Conclusion

This study examined the factors that influence the career decision-making of undergraduate STEM students at a university in South Africa. Uniquely, the study engaged a qualitative research method in contrast to the rather prevalent quantitative approach. Irrespective of the limitations about the data source highlighted above, this study provided significant insights for understanding the way to enhance and sustain the pipeline into the STEM area of study. By investigating the influence of various factors on a student's decision to pursue a career in STEM, this study provides more information on the role of interpersonal, intrapersonal and outcomes expectancy in the decision-making behaviour of STEM students. Under SCCT, belief in self-abilities work in a system of socio-cultural and socio-economic contexts to influence career decision-making conduct, while the personality typology (Holland, 1959) reveals that personality has an important influence on students' decision to pursue a career in STEM. The findings provide teachers, career advisors, administrators and stakeholders in STEM with extra information concerning precisely what factors influence the decision to pursue a career in STEM. This can increase South Africa's capacity to grow the category of skilled workforce needed to be competitive in the global workplace of the fourth industrial revolution (4IR).

Acknowledgment

This paper is an output of the Department of Science and Technology/National Research Foundation, South Africa funded Innovations research project.

References

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self- efficacy beliefs as shapers of children's aspirations and career trajectories. *Child development*, 72(1), 187-206.

Bandura, A. (1977). Self-efficacy: *The exercise of control*. New York: Freeman

Bieri Buschor, C., Berweger, S., Keck Frei, A., & Kappler, C. (2014). Majoring in STEM—what accounts for women's career decision making? A mixed method study. *The Journal of Educational Research*, 107(3), 167-176.

Brophy, J. (2006). History of research on classroom management. *Handbook of classroom management: Research, practice, and contemporary issues*, 17-43.

Chen, P. D., & Simpson, P. A. (2015). Does personality matter? Applying Holland's Typology to analyze students' self-selection into science, technology, engineering, and mathematics majors. *The Journal of Higher Education*, 86(5), 725-750.

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2007). *How and why do teacher credentials matter for student achievement?* (No. w12828). National Bureau of Economic Research: Cambridge.

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology*, 13(1), 3-21.

Dabney, K. P., Tai, R. H., Almarode, J. T., Miller-Friedmann, J. L., Sonnert, G., Sadler, P. M., & Hazari, Z. (2012). Out-of-school time science activities and their association with career interest in STEM. *International Journal of Science Education, Part B*, 2(1), 63-79.

Eccles JS, Wigfield A, Schiefele U. Motivation to succeed (1997). In: W. Damon, N. Eisenberg, (Ed). *Handbook of child psychology*. (pp. 1017–1095). New York: Wiley

Estrada, M., Eroy- Reveles, A., & Matsui, J. (2018). The influence of affirming kindness and community on broadening participation in STEM career pathways. *Social issues and policy review*, 12(1), 258-297.

Nkosikhona Duma. (2019) Academic group: Students using funding to support families. Eye Witness News https://ewn.co.za/2019/10/02/academic-group-students-using-nsfas-funds-to-support-families-not-buy-books. . Accessed 14 October 2019

Fogarty, G. J., & McGregor-Bayne, H. (2008). Factors that influence career decision-making among elite athletes. *Australian Journal of Career Development*, 17(3), 26-38.

Fouad, N. A., & Smith, P. L. (1996). A test of a social cognitive model for middle school students: Math and science. *Journal of Counseling Psychology*, 43(3), 338.

Gall, M., Gall, J., & Borg, W. (2003). *Educational Research*. Boston: Pearson Education, Inc.

Gelatt, H. B. (1962). Decision-making: A conceptual frame of reference for counseling. *Journal of Counseling psychology*, 9(3), 240.

Jacobs, J. E., Chhin, C. S., & Bleeker, M. M. (2006). Enduring links: Parents' expectations and their young adult children's gender-typed occupational choices. *Educational Research and Evaluation*, 12(4), 395-407.

Jacobs, J. E., Davis-Kean, P., Bleeker, M., Eccles, J. S., & Malanchuk, O. (2005). I can, but I don't want to. *The impact of parents, interests, and activities on gender differences in math. In A. Gallagher & J. Kaufman (Eds.), Gender difference in mathematics*, 246-263.

Hartung, P. J., Porfeli, E. J., & Vondracek, F. W. (2005). Child vocational development: A review and reconsideration. *Journal of vocational behavior*, 66(3), 385-419.

Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments*. Psychological Assessment Resources.

Holland, J. L. (1959). A theory of vocational choice. *Journal of counseling psychology*, 6(1), 35.

Hulleman, C. S., Durik, A. M., Schweigert, S. B., & Harackiewicz, J. M. (2008). Task values, achievement goals, and interest: An integrative analysis. *Journal of educational psychology*, 100(2), 398.

Kirby, N. F., & Dempster, E. R. (2018). Alternative Access to Tertiary Science Study in South Africa: Dealing with 'Disadvantage', Student Diversity, and Discrepancies in Graduate Success. In C. I. Agosti and E. Bernat (Ed.) *University Pathway*

Programs: Local Responses within a Growing Global Trend, (pp. 85-106). Springer: Cham. Switzerland.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, 30(3), 607-610.

Lent, R. W., Lopez Jr, A. M., Lopez, F. G., & Sheu, H. B. (2008). Social cognitive career theory and the prediction of interests and choice goals in the computing disciplines. *Journal of Vocational Behavior*, 73(1), 52-62.

Lent, R. W., Brown, S. D., Sheu, H. B., Schmidt, J., Brenner, B. R., Gloster, C. S., ... & Treistman, D. (2005). Social cognitive predictors of academic interests and goals in engineering: Utility for women and students at historically black universities. *Journal of counseling psychology*, 52(1), 84-92.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of vocational behavior*, 45(1), 79-122.

Manuel, R. (2019). Ubuntu Ethics and The National Student Financial Aid Scheme. Thesis presented in fulfilment of the requirements for the degree of master's in applied business Ethics in the Department of Philosophy at Stellenbosch University. https://scholar.google.co.za/scholar?hl=en&as_sdt=0%2C5&q=Manuel%2C+R.+%282019%29.+Ubuntu+Ethics+and+The+National+Student+Financial+Aid+Scheme.&btnG= Accessed 22 October 2019

Maxwell, J. A. (2012). *Qualitative research design: An interactive approach* (Vol. 41). Washington DC: Sage publications.

Mills, J., Bonner, A., & Francis, K. (2006). The development of constructivist grounded theory. *International journal of qualitative methods*, 5(1), 25-35.

Mugenda, O.M., & Mugenda, A.G. (2003). *Research methods: Quantitative and qualitative approaches.* Nairobi: African Centre for Technology Studies

Niles, S. G., Amundson, N. E., & Neault, R. A. (2010). Career flow: A hope-centered approach to career development. Boston, MA: Pearson.

Nugent, G., Barker, B., Welch, G., Grandgenett, N., Wu, C., & Nelson, C. (2015). A model of factors contributing to STEM learning and career orientation. *International Journal of Science Education*, 37(7), 1067-1088.

Olitsky, S., Flohr, L. L., Gardner, J., & Billups, M. (2010). Coherence, contradiction, and the development of school science identities. *Journal of Research in Science Teaching*, 47(10), 1209-1228.

Pajares, F., & Valiante, G. (2001). Gender differences in writing motivation and achievement of middle school students: A function of gender orientation?. *Contemporary educational psychology*, 26(3), 366-381.

OECD. Publishing, Organisation for Economic Co-operation and Development Staff, & Centre for Educational Research and Innovation. (2005). *Education at a Glance 2005: OECD Indicators*. Organisation for Economic Co-operation and Development.

Paulsen, C., Cardella, M., Jones, T., & Wolsky, M. (2015). Informal Pathways to Engineering: Interim Findings from a Longitudinal Study. In *2015 ASEE Annual Conference & Exposition*.

Piansoongnern, O., & Anurit, P. (2010). Talent management: Quantitative and qualitative studies of HR practitioners in Thailand. *International Journal of Organizational Innovation (Online)*, 3(1), 280.

Pike, G. R. (2006). Students' personality types, intended majors, and college expectations: Further evidence concerning psychological and sociological interpretations of Holland's theory. *Research in Higher Education*, 47(7), 801-822.

Planet Earth Institute. (2016). What is the scientific independence of Africa? Accessed 1 November 2016, from http://planetearthinstitute.org.uk/about-scientific-independence/

Prince, R. (2017). The relationship between school-leaving examinations and university entrance assessments: The case of the South African system. *Journal of Education (University of KwaZulu-Natal)*, (70), 133-160.

Reagans, R., & Zuckerman, E. W. (2001). Networks, diversity, and productivity: The social capital of corporate R&D teams. *Organization science*, 12(4), 502-517.

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica*, 73(2), 417-458.

Seibert, S. E., & Kraimer, M. L. (2001). The five-factor model of personality and career success. *Journal of vocational behavior*, 58(1), 1-21.

Strauss, A. L. (1987). *Qualitative analysis for social scientists*. Cambridge university press.

Sullivan, B. A., & Hansen, J. I. C. (2004). Mapping Associations Between Interests and Personality: Toward a Conceptual Understanding of Individual Differences in Vocational Behavior. *Journal of counseling psychology*, 51(3), 287.

Tai, R. H., Liu, C. Q., Maltese, A. V., & Fan, X. (2006). *Planning early for careers in science*. Sciences, 312, 1143–1144

Tate, K. A., Fouad, N. A., Marks, L. R., Young, G., Guzman, E., & Williams, E. G. (2015). Underrepresented first-generation, low-income college students' pursuit of a graduate education: Investigating the influence of self-efficacy, coping efficacy, and family influence. *Journal of Career Assessment*, 23(3), 427-441.

Tikly, L., Joubert, M., Barrett, A. M., Bainton, D., Cameron, L., & Doyle, H. (2018). *Supporting secondary school STEM education for sustainable development in Africa*. Bristol Working Papers in Education.

Turner III, D. W. (2010). Qualitative interview design: A practical guide for novice investigators. *The qualitative report*, 15(3), 754-760.

Van der Berg, S., & Burger, R. (2003). *Education and socio-economic differentials: A study of school performance in the Western Cape*. University of Cape Town.

Vedder- Weiss, D., & Fortus, D. (2013). School, teacher, peers, and parents' goals emphases and adolescents' motivation to learn science in and out of school. *Journal of Research in Science Teaching*, 50(8), 952-988.

Wang, M. T., & Eccles, J. S. (2012). Social support matters: Longitudinal effects of social support on three dimensions of school engagement from middle to high school. *Child development*, 83(3), 877-895.

Wang, M. T., & Degol, J. L. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. *Educational psychology review*, *29*(1), 119-140.

Watt, H. M., & Eccles, J. S. (2008). *Gender and occupational outcomes: Longitudinal assessments of individual, social, and cultural influences*. American Psychological Association.

Workman, J. L. (2015). Parental influence on exploratory students' college choice, major, and career decision making. *College Student Journal*, 49(1), 23-30.

Zimmerman, B. J. (2013). Theories of self-regulated learning and academic achievement: An overview and analysis. In *Self-regulated learning and academic achievement* (pp. 10-45). Routledge.