WAYS TO GO: A grounded theory study of how the laboratory culture in the applied sciences impact on international doctoral students' career paths in the STEM/applied sciences

by

Olukemi Adedolapo Olugbade

A thesis submitted in partial fulfilment of the requirements for the degree of

Master of Arts

in

Community Engagement

School of Public Health
University of Alberta

ABSTRACT

As Canadian Universities join in the global realization of the *Third mission* and become more entrepreneurial, international students' participation in this agenda is pivotal to its success as they form about a half of STEM doctoral students in the country. Extant studies have either been positioned as studies on international students, studies on race or gender, or wholly on the doctoral students' community. This is a study of the international doctoral students' community within the academic community of practice designed to understand the impact of the research laboratory cultures these students find themselves immersed into on their career trajectory after graduation. This research will study mid-program international students in years three to five of their STEM doctoral programs through a grounded theory study. The research studied international students STEM and applied sciences doctoral programs in years three and above using a constructivist grounded theory methodology. The study was designed to understand these students perceptions of the research laboratory cultures, their self-description and assessment of their lived experiences in these laboratory cultures, the impact of the culture on them and their career trajectories since resumption of their programs of study, and other nuances that are elicited by the outcome of study by applying the international student lens on career theories.

The finding from the study indicated additional factors beyond the academic socialization on international STEM and applied sciences PhD students post-graduation career choices. The relevance of additional internal and external factors such as family, international-ness, language and accentedness, and academic socialization experiences, are grounded in personal contexts and deployed to determine how these students make their post-graduation career decisions.

PREFACE

This thesis is an original work by Olugbade Olukemi Adedolapo. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name "**WAYS TO GO: A grounded theory study of how the laboratory culture in the applied sciences impact on international doctoral students' career paths in the STEM/applied sciences**.", No. Pro00117497, March 1, 2022.

DEDICATIONS

"All praises belong to the God and Father of our Lord Jesus Christ. For he is the Father of tender mercy and the God of endless comfort. He always comes alongside us to comfort us in every suffering so that we can come alongside those who are in any painful trial. We can bring them this same comfort that God has poured out upon us." (1 Corinthians 1:3-4 TPT)

I dedicate this thesis first to the God and father of my Lord Jesus Christ who is the source of my life and who gave me the opportunity to participate in this program, providing me the resources and empowerment necessary.

I also dedicate this thesis to my beloved husband, Olanrewaju Oladapo, whose sacrifices towards ensuring I accomplish my dreams are limitless, thanks for the love and support. Also to my children, Toluwanimi and Araoluwa, without whose support and emotional sacrifices I could not accomplish this.

ACKNOWLEDGEMENT

I use this opportunity to acknowledge the support and encouragement from my supervisor, Dr. Kent Rondeau, who's constant validation was invaluable to the completion of this thesis. To the other members of my research committee, Dr Micheal Lipsett (faculty of engineering, University of Alberta), and Dr Kate Storey (School of Public Health, University of Alberta) for all your support. To my beloved HOD of Community Engagement at the School of Public Health, Dr Mary Beckie, I express my resounding gratitude for not allowing me to drop the baton.

I also acknowledge the immerse support from my colleagues as members of the COVID-19 pandemic cohort, especially the friendship of Maricruz, Prime, Tanya, Sara, and Reem. You all made the program better for me.

Kruzeh, thank you for funding my studies and loving me forever through it all.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1 - INTRODUCTION

Globally, there has been a shift in the academia's direction about how best to educate their students to create both a pool of academic experts and industry innovators, and entrepreneurs. This shift is created to harness the socio-economic developmental potential of universities' local communities and has been tagged the *third mission.* This third mission has been defined as additional community and economic development activities (Bienkowska, et al., 2016; Etzkowitz,1983; Giroux, 2002; Klofsten & Jones-Evans, 2000; Padfield & Mora, 2008) in addition to universities' initial missions of teaching and research (Nelles & Volley, 2009, p.4; Padfield & Mora, 2008; Walsh, et al., 2015). What constitutes the third mission has included collaborations with industry, commercialization of research outcomes, consulting, patenting, innovations and start-ups ventures; which create a vagueness in the definition of what *third mission* is, even as it is gaining considerable grounds within the academic communities (Klofsten & Jones-Evans, 2000, p. 300; Padfield & Mora, 2008), especially in the applied sciences (Bercovitz & Feldman, 2008, p. 84; Nelles & Volley, 2009, p. 4). For this study, specification about what universities consider as entrepreneurship is deemed to include innovation, patenting, startups and new business formation. Other forms of collaboration like research collaboration, consultancy with industry or government, and commercialization of research laboratory activities are aggregated as engagement with industry or government.

As these commercialization activities have been averred as a major fund raiser for the universities, the performance of research and sale of the results to private enterprises are on the increase (Berkovitz & Feldman, 2008, p. 73; Etzkowitz, 1983, p.198; Giroux, 2002; Muscio, et al., 2016, p.1388; Nelles & Volley, 2009, p. 164). However, some tensions are still perceptible between the academic ranks with concerns about the traditional ethos of the scientific research communities about practices of profit-seeking, either for public or private advantages, which may be detracting (Ertzkowitz, 1983, p.198). Increasingly however, more higher education

institutions (HEIs) are catching up to this objective at varied paces (Bienkowski, et al, 2015, p. 56; Bienkowski & Klofsten, 2011) with implications on the number and socialization process of doctoral students (Etzkowitz, 1983; Bienkowski & Klofsten, 2011). These universities now reify *third mission* academic programs as "socially-shared knowledge-based" engines aimed at stimulating local economic growth and social well-being, rather than an "individual curiosity-based" vehicle (Bienkowski, et al, p. 57; Hixson & Pareti, p. 2).

The implications of these for the socialization of doctoral students in the academic communities can be evaluated by the proliferation of university-industry relations through such initiatives as commercial spin-offs, Technology Transfer Offices (TTOs), highly educated entrepreneurially oriented individuals for the regional labour market, entrepreneurial hubs, consultancy offices/services, and contract research projects (Bienkowska & Klofsten, 2011, p. 207; Etzkowitz, 1983; Etzkowitz, et al, 2015; Hixson & Pareti, 2018; Giroux, 2002), forming a three-dimensional linkage between university-government-industry, referred to as the "Triple helix" (Etzkowitz, 1983). Doctoral students are thus positioned at the epicentre of the triple helix initiatives as the research workers within today's academic communities (Bienkowski & Klofsten, p. 208; Kitagawa, 2015; Thune, 2009; Walsh, et al., 2015). They are part of research groups run akin to '…private business firms in their administrative structure, financial arrangements and appointive policies.' (Etzkowitz, 1983, p.216; Thune, 2009, p.637; Walsh, et al., 2015, p. 777). Indications of this unfolding phenomenon within the academic communities expectedly direct the paths of doctoral students' career trajectories.

Included in this pool of doctoral students are the international doctoral students; students who traversed national boundaries in pursuit of doctoral studies. International students are typically students who arrive in the country of their study with study permit visas. Generally, international students have the attribute of increasing the cultural diversity of students' population which increases heterogeneity and globalization of innovations in graduate education

(Gupta, et al., 2022, p. 2). For the sake of this study however, international students consist of all students who commenced their studies as international students, irrespective of their current immigration status in Canada. This study aims to give voices to international students to explain how they navigate the socialization and career processes while still within the system, thus giving appreciation for what factors are most impactful, how these factors impacted, and what evolutions they perceive themselves to experience because of these factors and why. Focusing on students in years three and higher in the STEM courses because they are perceived to be more amenable to commercialization and entrepreneurship among university courses, participants have lived experiences of these factors and the perceived impact, while with the vantage of future contemplation.

Research Question

Conceptualizing the academic community as described by Young (1986, p. 7) as "… a relation … by identification and symmetry among individuals within a totality...", international doctoral/PhD students in the applied science (STEM) programs form a viable community within the multifaceted academic community, which is a community of communities. As a place-based community, the academic community within the university of Alberta consists of several embedded smaller local communities and communities of practice. The international students in the STEM programs are thus located at the intersections of their course, faculty, fellow students, and other international student communities within the academia, as well as several other contextual and familial communities within and outside Canada. These connections spawn very heterogenous linkages and intersectionalities among the international doctoral student communities. Varied as these students' intersectionalities are, they proffer suggestions of similarities in their perceptions and experiences. This study was designed to consider how these variations and commonalities in international students' perceptions impact further realization of

the *third mission* objectives as Canadian universities intensify efforts to attract more international students.

In its 2019 report, Council of Ministers of Education, Canada reported the country employed close to fifty percent STEM doctoral students internationally (CMEC, 2019), compelling a need to delve into the layers of their socialization process. Of Canada's STEM doctoral graduates between 2010 and 2018 international students rose to 41% at masters and doctoral level (CMEC, 2019, p. 15), with Alberta having the second largest number of doctoral STEM students after Newfoundland and Labrador (CMEC, p.28), making the region and the university of Alberta ideal for this study. This paper therefore sought to understand these students' perspective on their research group's socialization culture and process, while examining the lead scientist's (supervisor/principal investigator's) impact on their future career trajectory. The main question of study is to answer: 'How has the research laboratory culture impacted on the international STEM PhD students' self-reported projected career trajectories as they proceed in their doctorate program?'.

Accomplishing this with constructivist grounded theory methodology could produce answers to the following questions among other possibilities: a) How do laboratory group entrepreneurial cultures vary within the university's STEM departments? b) What variables do the international students adduce these variations to? c) How have these established laboratory entrepreneurial cultures impacted students' career identity, socialization and evolution in the students' perception? d) How do the students project these perceptions impact their career decisions about their post-doc engagement? e) How strongly do they perceive their lead scientist's engagement culture impacts on their personal planned trajectories? (f) What additional intersectional variables do they identify as most strongly significant in their decisions as international students, if any?

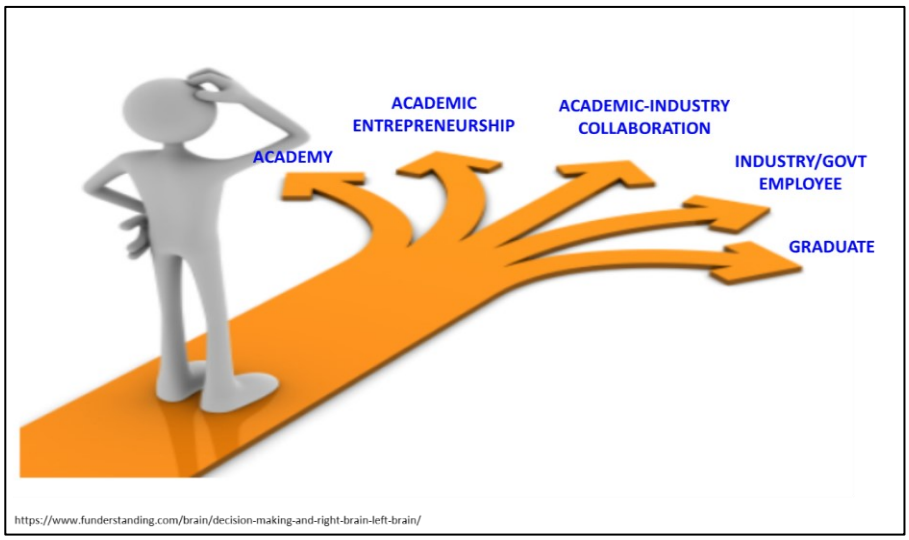
Using a constructivist grounded theory methodology, data was co-created with international STEM PhD students in years three and above at the University of Alberta. Participants for the study cut across engineering and the applied sciences, both male and female, married and unmarried, and from different regions of the world. Some participants status had changed from international student to resident permit holders, but they all arrived into Canada with the former status. One-on-one interview sessions were conducted virtually, and a focus group session with five of the participants was conducted to round up the data creation. Data was analyzed and the concluding theory interpreted using the big five career theories framework (Lent, 2005; Leung, 2008). Theory emerging from this study is relevant for policy makers and doctoral students' supervisors, departments, faculties, university governance as well as industry and government in positioning towards the greater achievements of the *third mission* objectives in academic communities.

Purpose

Studies have positioned doctoral students, local and international, as members of the academic community and communities of practice (Andersson, 2017; Feng Teng, 2020), legitimizing studying their socialization processes as a community. Evaluating the interplay and intersections of the research laboratory cultures, especially for international students, is an opportunity to distinguish and validate the homogeneity of structures and heterogeneity of contexts fitted into the tag - international student. Amplification of structural and practical catalysts for efficiency attenuated by international STEM students in this study should create a model for reformation of the academic community's socialization processes, and specific research laboratory experiences that impact career trajectories. It offers a pertinent opportunity to inculcate the heterogeneity of the international students' community and agency into producing co-created best-practice models of socialization processes.

This study aimed to amplify international students' own perceptions of what serves as impetus for their future career paths. To this end, career paths are divided into: (a) *Academia* – where students aspire towards the traditional university research and teaching; (b) *Academic entrepreneurship* – where students establish start-ups and collaborate with industry; (c) *Academic-industry collaborators* – where students are receptive to collaborations with industry but do not intend to strike out on a complete entrepreneurial limb so maintain academic positions; (d) *Research industry/government employees* – where students perceiving doctoral studies as additional preparation for employment and pivot their training towards preferred employment only; and (e) *(Non) Graduates* – where students decide either to discontinue their studies or not to take up any usual post-doctoral career, whatever their reasons.

Figure 1- Possible Career Pathways



Definition of terms in the paper

Engagement

Throughout this paper the word engagement is used to indicate different types of relationships between the international student, their research laboratories, the academic community, and industry. Engagement with the academia included collaborations with other researchers, participation in conferences, seminars and symposia, and other forms of interactions within the academia during the PhD student's professional socialization. Engagement with industry includes all forms of interactions students have with industry as part of their socialization process in their PhD program including collaborations on research projects, consulting on industrial projects, participating in industry conferences, seminars and symposia, and other activities that bring students into working proximity with members of the profession they belong to in industry. Some of the industry engagements are in the form of consultancy, commercialization, research and development, and other forms of partnership. Engagement with government will include participation in collaborations with governmental agencies in policy development, consultancy, conferences, and any other form of interactions involving the government.

Accentedness

The term accentedness in this paper refers to Canadian perceptions of how international students pronounce English words, and how the sounds pronounced differ from general Canadian pronunciations. Although accents reflect an individual's background and context (Boonstuk & Fang, 2022, p. 42; Kong & Kang, 2022, p. 515), many native and non-native speakers formulate opinions about accented speakers. Being accented is also associated with native English speakers from other regions and nations of the world, example Australian or British accents, and Nigerian or Indian accent from among the British commonwealths. Other nationalities, especially individuals who leant to speak English as an additional language because they are non-native speakers such as Chinese or Spanish students also speak differently from Canadian students and are considered accented. Accentedness further refers to the

stereotypes accented English speakers face when relating with locals, students, supervisors, faculty, staff, and local community. In this paper, accentedness is not limited but implies all possible responses and reactions international students receive because of how they sound. This includes stereotypes, acceptances, reactions, and attitudes resulting from being individuals who speak the English language differently from the local Canadians.

Internationalness

Internationalness in this paper does not only refer to the student belonging to a different nationality than Canada but to the totality of ensuing variable contextual background. Being international is the foundational attribute of internationalness, while the implication extends to other heterogenous attributes of individual international students that result from their backgrounds, experiences, goals, and desires (Montgomery, p. 79). Internationalness as used in this study also reflects the responses and reactions being international foists on students, whether from their research laboratories, academic communities of practice, the university, local community, and governmental organizations. It represents the differences between home students and their international counterparts in interactions, actions, perceptions, judgements, decisions, and motivations (Montgomery, p. 79). As an example, internationalness explains the difference between international students' assumption of deep friendly relationships when Canadians apologize and say 'sorry', whereas for the Canadians it just a matter of politeness. Overall, internationalness impacts on how students socialize and form relationships, networks, and interpret experiences, learn and respond to motivation and resources, relative to expected outcomes from Canadian students, given the same circumstances.

Abbreviations Used

This paper uses some abbreviations to prevent repetitiveness. Specifically, because the participants in this study were given anonymity, each participant was granted a code name during the interview and focus group sessions. The codes served to protect their identities and prevent any information that could be traceable in this paper. These codes are perpetuated in this report whenever reference is made to any of the participants, and which session the report is culled from. For clarity in reading, below is the list of codes used to represent the participants.

Table 1- Definition of Terms in Report

Code	Reference
P1	Participant 1
P2	Participant 2
P3	Participant 3
P4	Participant 4
P5	Participant 5
P6	Participant 6
P7	Participant 7
P8	Participant 8
S1	Interview session 1
S2	Interview session 2
S3	Interview session 3
FG	Focus Group session

The codes are also used to identify the specific one-on-one interview session each participant referred to in the report. In addition, five of the participants willingly took part in a focus group session using their coded reference names. To report the data accurately while avoiding repetition, codes were further used to represent each session. These codes are explained in the table above. In essence, a reference to a quote written as P6-S3 attributes the statement to participant 6 during interview session 3; while FG-P2 refers to comments by participant 2 during the focus group session.

Summary of Findings and Theory Formulated

This study was designed to hear from international STEM PhD students and understand their perspectives about how their research laboratory culture impacts their decisions towards postgraduation career. The study was conducted under the lens of the entrepreneurial university model as explained by Henry Etzkowitz (1983) to understand the cultures research laboratories build around the triple helix. How much individual supervisors or principal investigators in research laboratories expose their group members towards collaborations with university (academia), industry and government are entrenched into the cultures created. These exposure to engagement cultures the students towards future career possibilities and sometimes gives access to specific career directives.

Specifically for international students, their research laboratory experiences form perspectives of the reality through which they evaluate and form opinions and build their identity in the nation of Canada as foreigners. International students consistently reported a dualism in perspectives about issues graduate students face because they are foreigners in the country and bound by additional challenges as established by the immigration laws. Individual ambitions drive the initial decisions to pursue a doctorate program and propel the choice of research laboratory options these students apply to. However, the reality of their knowledge about the work in the laboratory is as expressed on the laboratory websites, but knowledge about laboratory culture and their fit therein will only come experientially.

The laboratory culture includes the academic and non-academic exposures students receive in the process of socialization within the research laboratories they belong to. The design of the laboratory culture is dependent on the supervisor. Supervisors determine the leadership and organizational structure to adopt in their laboratories and forge the relationships the students

in the laboratories work to support. Supervisors also determine the preferred communication patterns in their laboratories for all members to follow. The effects of these culture created within the laboratories cannot be assessed online through websites or emails, but rather through experience. Depending on the individual international student's circumstances and perceptions about the modus operandi within their research laboratory, they may align with ease or be considerably challenged by the direction of their laboratory; students still must conform to the culture. Working within certain laboratory cultures thus perpetuate the supervisor's engagement practices upon graduation.

However, the international student arrives at the research laboratory with certain inherent handicaps dissimilar to their Canadian counterparts. International students' ability to function in the country and tow the lines of their dreams is shrouded by the immigration regulations. Assumedly, this puts all international students under a blanket need for broad-minded adaptation into their research laboratories, universities, and country, expecting them to cope according to certain expectations. These expectations are built on premises that assign homogeneity to international students' contexts, opinions, perspectives, situations, and adaptability. This study shows this is unfounded. It further shows how these variations in students circumstances supersedes other factors in determining how international students make their postgraduation decisions. These circumstances create what this study calls 'social expectations', comprising of both the 'academic expectations' built from their laboratory socialization experiences, and their 'familial expectations' comprising of the medley of individual variableness. In other words, what type of laboratory culture, leadership and structures, and consequent network these international STEM students experience is a strong lead towards their career decisions. With international students, unlike with Canadian students, laboratory socialization works in tandem with the variable of immigration intention and status, language proficiency and accented-ness, and personal circumstances.

The big five career development theories of (a) Theory of Work Adjustment, (b) Holland's Theory of Vocational Personalities in Work Environment, (c) Super's Self- concept Theory of Career Development, (d) Gottfried's Theory of Circumscription and compromise, and (e) Social Cognitive Career Theory, were used to evaluate the emergent social expectations theory as per Leung's (2008, p. 115) work. A convergence of the major factors from the big five theories is used to further appraise and rationalize the emergent theory of social expectations from this study.

Chapter 2 - LITERATURE REVIEW

In this chapter literature is examined to explore the nuances of the issues studied in this research project. This study was designed to understand how the entrepreneurial university's third mission agenda is being discharged within the University of Alberta. The university has an established Technology Transfer Office (TTO), the eHUB Entrepreneurship Center which are involved in several initiatives to promote innovation and entrepreneurship within the university community, and various industry and government related collaborations. At the heart of these are the students, specifically doctoral students, who work under the directions of their professors, also called supervisors or principal investigators (PI) under these initiatives.

This study was to understand the specific dynamics that determine how university students in the STEM and Applied Sciences are guided into making career choices after graduation, based on their acculturation process at the research laboratory. Unpacking the research question requires understanding the entrepreneurial university, the triple helix model of engagement, the third mission agenda, doctoral students, international doctoral students, academic identity, and career development.

The Entrepreneurial university

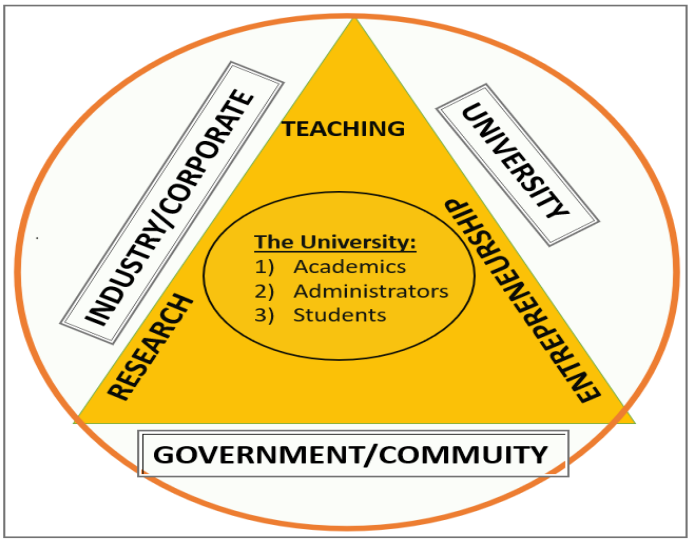
After World War II, the role of the Universities began to stretch beyond mere citadels of knowledge creation for its own sake and rather started including efforts to entrench these Higher Educational Institutions (HEIs) into the socio-economic landscapes of their communities (Ertzkowitz, 2015, p. 245; Klofsten & Jones-Evans, 2000, p. 299; Nelles & Volley, p. 162). Flagging off such collaborations post WWII was the German government led initiative for government-university collaborations which served to extend relationships created during the war (Ertzkowitz, 1983, p. 200). Universities and HEIs were already a fixture of many major cities impacted by both the WWII and the great depression, thus it seemed appropriate to

authorities to take advantage of their repertoire of knowledge to rebuild after the war by taking advantage of the public–private partnerships deployed during the war (Ertzkowitz, 2006; Ertzkowitz, 2015, p. 244). Directly involving academia in research, development, and knowledge creation alongside with, and aimed at industry and government/societal development soon gained traction in industrial and developing societies, birthing the 'Entrepreneurial University' (Ertzwoitz, 2015, p.244).

The opportunities created by the deployment of the entrepreneurial university framework enabled increasing collaborations between industry-university-government and universities in the United States and the rest of the world soon tapped into it (Etzkowitz, 1983, p. 208). This relationship is called the 'Triple Helix' and it formally introduced the "Third Mission" of entrepreneurship into the university's roles in society, in addition to the erstwhile missions of teaching and research. This shift in emphasis in university education from the core missions of teaching and research to include commercially oriented activities serving industry, government and trans-national/multi-national organizations, has made entrepreneurship a complementary part of research, especially in the applied sciences (Ertzkowitz, p. 219; Nelles & Volley, p. 162).

The resultant effect of this across board is the increased number of students accepted into the graduate programmes in HEIs globally because of the increasing activities university laboratories are addressing (Ertzkowitz, p. 220). Evolving into this role therefore expanded the role of research laboratory heads or Principal Investigators, especially in the STEM and Applied Sciences to forge strategies that enable these collaborations between the academia, the industry and government (Nelles & Volley, p.162).

Figure 2 – The Entrepreneurial University



Etzkowitz & Zhou (2018, p. 23) explain the interaction between university, industry and government within the helix as non-discriminatory to either individual or industrial entrepreneurs, thereby providing an avenue for the continuing flow of innovation from the dynamic membership of university research laboratories into the more static industry and government spheres of research and practice. The university's advantage is derived from the constant flow of students in the research laboratories, propelling the university's contribution of basic research into the helix, while industry enables product, and government, policy (Etzkowitz & Zhou, 2018, p. 26). Operating the triple helix model is lauded as opening the regions of domicile to social and economic development (Centobelli, et al., 2019, p. 176; Etzkowitz, 2019, p. 85; Etzkowitz, 2018, p. 32), though its noteworthy that "… (its) not a magic wand" (Rieu, 2014, p.2); the process of working the triple helix is the third mission.

The Third Mission

Imbibing the Third Mission agenda implies universities play more actively in the sphere of innovation, research and development, and consultancy for industry and government in what is called the knowledge economy (Etzkowitz, 2019, p. 84; Thune, 2010, p. 465). Etzkowitz

refers to the development of this 'knowledge economy' using the entrepreneurial university framework "…(as) the key element of a knowledge-based region's infrastructure, superseding tunnels, bridges and roadways in importance", and a departure from industrial society based on government– industry relations (Etzkowitz, 2019, p. 84). Universities operating the *third mission* become agents of "…knowledge transfer … (for) social and economic development … (beyond) … research and teaching…" (Etzkowitz, p. 84).

Universities find various ways to fulfil the third mission through the development of various "…market-based activities and services within the education, research … areas…" (Thune, 2010, p. 465). This process involves capitalizing knowledge, starting new commercial entities, and becoming more entrepreneurial, prompting increase in patenting and licensing, and the creation of science parks, spin-offs and incubators (Klofsten & Jones-Evans, 2000, p. 300; Thune, 2010, p. 465). Miller, et al.(2018, p.11) categorize these as formal entrepreneurial university activities, adding the informal activities to include "…consulting, joint/collaborative research, contract research, shared facilities, training and continued professional development, students placements…".

University Research groups

The evolution of the entrepreneurial university necessitates the revision of university structures and policies as third mission activities force an intertwining of roles within the triple helix resulting from goals commonality, creating hybrid organizations (Thune, 2010, p. 465). Using Stanford, MIT and Cambridge as role models, universities interact with industry and external organizations, impacting on how universities operate (Bienkowska, et al., 2015; Bienkowska & Klofsten, 2012, p. 208; Nelles & Vorley, p. 164). Various concerns about the implications of this have been raised including factors like 'Academic Capitalism', and that not all universities and not all disciplines within universities can benefit from the triple helix model

(Nelles & Vorley, p. 164). Research indicates prevalence of entrepreneurial activities in engineering, science and medicine relative to social sciences, arts and humanities (Bienkowska & Klofsten, p. 210).

Bearing on the tripartite interactions portended by the triple helix, scholars suggest training and socialization competence development be re-structured to accommodate the third mission in participating universities (Thune, 2010, p. 465). Research training remains at the focal point of the entrepreneurial universities' socialization processes, alongside other learning outcomes and competence development necessary for employability, entrepreneurship education, and industry collaborations (Bienkowska, et al., p. 56; Thune, 2010, p. 465). Organizing research groups to accommodate these third mission activities require universities to establish multi-level authority and hierarchical structures encompassing university, faculties, departments, as well as academics (Bienkowska, et al., 2015, p. 58; Bienkowski & Klofsten, p. 209; Etzkowitz, 1983, p. 216). Each scientist's relationship with the private sector, lends to the structure of their laboratories, the number of doctoral students they train, and their students socialization dynamics into the relevant communities of practice (Anderson, 2017, p. 2; Bienkowski, et al., p. 59; Ertzkowitz, p. 227).

Doctoral students

Doctoral students are pivotal to the university systems as research workers at universities (Thune, 2009, p. 638). In the applied sciences, doctoral students are increasingly socialized into entrepreneurship/commercialization through collaborations with industry as they progress in their studies and eventual career choices (Bienkowska, et al., p. 58; Bienskowska, et al, 2016, p.57; Thune, 2009; Walsh, et al., 2015, p. 776), making them what Kitagawa (p. 331) calls '*bridging scientists*'. Thune (2009, p. 637) explicates on the effects of "… how knowledge … produced (by) increasing interactions between universities and industry and changes in labour

market…" has on doctoral students. Contemporary academic community socialization drives students in research laboratory groups headed by professors with the objective of increased entrepreneurial capacities now more than in previous decades (Bienkowska & Klofsten, p. 210; Bienkowka, et al., p. 59; Thune, p. 638). Expecting doctoral students to graduate with broader skill sets than previously required, they have increased exposure to "…real life problems…" through the third mission in the triple helix (Thune, 2020, p. 466). Such requirement extends the communities of practice into which these students are being socialized.

Some studies have highlighted the positioning of doctoral students within the tiers of university structures towards successful accomplishment of third mission objectives as future research leaders with possibility of acting entrepreneurially (Bienkowska, et al, p. 58; Bienkowska & Klofsten, p. 210; Thune, 2010, p. 465). Similarly, local university context, group norms and structures, and research group influences on doctoral students' socialization processes have been raised (Bienkowska, et al., 2016; Kitagawa, 2014; Thune, 2009; Walsh, et al., 2015) in extant literature. The roles of lead scientists' affinity towards collaborations, entrepreneurship or even aversion thereto, how it impacts the research group culture and structure, and its implication for doctoral students' socialization is noted in several studies (Bienkowska, et al, 2016: Thune, 2009).

Overall, the triple helix model impacts on how doctoral students are socialized in the laboratories, equipping them with broader skill sets for positions in academia, industry and/or government. This impact has been more distinguishable in the fields of engineering, life sciences and natural sciences where university-industry collaborations have become "normalized practice" (Thune, 2009, p. 646). Research indicates university-industry collaborations in these fields are well embraced globally, with such things as resource involvement, type of firm and/or degree of formalization of relationships with collaborators, all impacting on students' experiences. Some studies have indicated that in the United States, non-academic career

pathways are directly or unwittingly compromised by faculty members (Cason, 2016, p. 4). It also indicates that 'first generation' graduate students comprises of "…Black, Hispanic, American Indian/Alaska Native, students who have identified with two or more races, persons with disabilities, women in STEM fields …", and under perform their peers (Cason, p.3). This could be considered indicative of the international doctoral student.

International Students

Cason's study segregates underrepresented 'first generation' students from the overall students' population in the United States and although it picks on the likely nationalities of many international students, it does not focus on them. Generically, students tend to be homogenized in study populations, and using Cason as example, there is usually no delineation from local/resident students and internationals. Montgomery (2010, p. xvii, 97), expiates the complexity of the 'international student' in her study of international students in British universities. Her study was aimed at elucidating on the social and academic experiences of international students in higher educational institutions in the United Kingdom (UK). The summary of her findings included (a) International students use frequent contact with family back home to navigate the loneliness and aloneness of their first year, building an international social group over the following years of study to tide over these challenges; (b) Despite the need for support social groups, she describes international students as 'fiercely independent", mostly able to forge their own paths when necessary; (c) There's a preconception, both by local and international students, which expects internationals to 'need' friendships with local students, which she termed "the deficit model"; (d) Fellow international students exhibit greater ability to understand other international students varied language issues than local students; (e) International students perceive themselves as being more matured and worldly wise than local

students; and (f) Prejudice and preconceived ideas among both local and international students produce both negative and positive interpretations among both groups of students.

Further, Dos Santos (2019, p. 2) highlights some of the reasons East Asian international students go to school in the United States to include access to courses and programmes unavailable in their home country, opportunity to access international careers, and avenue to learn and practise the use of the English language. Social, cultural and language concerns have also been identified as stressors for international students in Turkey (Dos Santos, p. 3; Elemo & Türküm, 2019, p. 8). Dos Santos (p. 3) differentiated the experiences of international students from those of 'westernized' American students of foreign extracts because the international students have had little opportunities to live within the university location's social and cultural environment. Both Dos Santos (p. 3) and Elemo & Türküm (p. 8) further differentiate between multiple international students' experiences based on personal coping abilities, denoting intersectionality among international students, indicating a differential in expected responses to stimuli, and outcomes. Despite these differences international students increasingly register in universities across the western world, including Canada and the University of Alberta.

International Doctoral Students

Elliot, et al (2016b, p. 734) describe the international doctoral students as those "… who pursue their PhD study in a 'foreign' context". They discuss the importance of identifying and making conscious efforts to harness the 'hidden curriculum' in students' socialization as crucial for helping these students thrive. They frame the complex transitioning challenges international doctoral students face as their 'sojourn' in the doctoral educations system and differences encountered resulting from variations in their contextual backgrounds (Elliot et al., 2016b, p. 736). This sojourn is an acculturation process explained using different model frameworks the primary of which is Bronfenbrenner's bio-ecological system framework which suggests that

everyone's unique development is shaped by a layered system in which the person stands at the very core.

Elliot, et al explain this framework as consisting of (a) The M*icrosystem/Mesosystem* – *microsystem* is made of direct interactions between the individuals and their environment such as family, school, peers and workplace; while the way these components interact among themselves like family–school links, is the *mesosystem*. (b) *Exosystem/Macrosystem* – The *Exosystem is* a second layer referring to external contexts in which the individual's immediate setting influences their development such as community, parents' social network and workplace, changes in which may affect growth and development; the *macrosystem*, represents social knowledge and cultural context passed on through societal norms, customs, traditions, and lifestyles, creating a national identity or societal blueprint. (c) *Chronosystem* – The *chronosystem* interconnects with the other four and represents the 'personal and historical' time dimension by taking into account major life events in a person's life such as changing family structure, employment, wars, and conflicts (Elliot, et al, 20116b, p. 736). Understanding the connections in the layers depicted by this acculturation model gives appreciation to the complexity of human development, and by extension the international doctoral student. The capacity of the research laboratory culture to deploying strategies that appreciate these connections, fill the gaps between them, and enable the efficient interaction between the layers for the socialization of international doctoral students is necessary for successful outcomes.

When socializing international students into their research groups, the differentiated cultural contexts between students in the group, between students and supervisors, and students and the university, posit further tensions for the entrepreneurial agenda in universities, faculties, departments or with entrepreneurial professors. Janssen, et al., (2020, p. 10) also related the tensions in didactic supervisor-student relationship where there are perceived misaligned expectations and its impact on students' success. This suggests greater complexity of

engagements when an international doctoral student is thrust into a misaligned research laboratory culture, this has serious implications for their career trajectories. Perkins, et al. (2017), state that engineering graduate students' successes are tied to "…their ability to fully engage with all aspects of their identity and feel connected…", basing doctoral socialization successes beyond academics and research.

Academic Identity

According to Engvall (2003, p. 17), self, identity, and community are formed by accommodations and contestations arising from how scholars perceive their own communities of scholars, as belonging or not belonging. How the scholars perceive these constructs feeds into their socially constructed knowledge, shapes their viewpoints and teaching curriculum, and eventually, the students' perceptions of the teachings and prospective professions. This is the summation of how professors' academic identity filters into their student's identity formation and consequent perceptions of probable career trajectories. Anderson & Mounts' (2012, p. 93) study explained the converse relationship between individual student's attribution of importance of a self or matter of concern, and uncertainty about their perception of self or matter of concern, affect their identity control. The implication of the above is that students' identities are manipulated by their perception of importance and uncertainty.

Academic identity for international students become more tenuous when the implication of internationalness is factored into their attribution of importance, and individual conceptions of certainty or uncertainty. How these students converge the "… dynamics between individuals, disciplines and the universities …" (Henkel, 2005, p. 155) are crucial to sense making and self esteem building up to academic identity formation. Rephrasing this then implies that academic identity formation equates to the individual student's perceptions of the academic environment and the sense they make of it. Consequently, students academic identity formation processes can

easily become a 'focused training' trap which Engvall warns can constrain trainees into "… narrow theoretical constructs …" while preparing them for professional roles in society (p. 76). The academic identity each individual student forms becomes a driver for the student's career aspirations making academic identity formation processes particularly pertinent for international students.

Theories of Career Development

The theories of career development connote a convergence of career choices and experiences over time (Osipow &Fitzgerald, 1996, p. 51). There are several career development theories, and Leung (2008, p. 115) explains the modifiers of the different theories as experiences, concerns, and shared issues. These theories serve a cross-cultural concern in the attainment of the individual's purposes. Leung proffered five theories of career developments which are used as an evaluation basis of this study's outcome as follows (a) Theory of Work-Adjustment, (b) Holland's Theory of Vocational Personalities in Work Environment, (c) the Self-concept Theory of Career Development formulated by Super and more recently by Savickas, (d) Gottfredson's Theory of Circumscription and Compromise, and (e) Social Cognitive Career Theory using an "international" perspective (p.116).

Summarizing these theories using Leung's explanations, the first theory, the Theory of Work Adjustment (TWA), is an extension of the personal environment correspondence theory by Dawis in 1992 (p.116). TWA proposed career choice and development is a continual process of adjustment and accommodation where people (P) seek organizational environments (E) that fit their needs, while the organizational environment (E) seeks individuals (P) who fit their requirements. It measures the degree of satisfaction of (P) with (E), and the satisfactoriness of (E) with (P) (p. 116). The second theory is Holland's Theory of Vocational Personalities in Work Environment (HT) (Holland, 1985, as cited by Leung, p. 118). Holland's theory (HT)

postulates that vocational interests are an expression of personality and interests for individuals. HT is a conceptualization of six vocational typologies, Realistic (R), Investigate (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C). The congruence of the person–environment interaction determines levels of career fulfilment or dissatisfaction (Leung, p. 118; Osipow & Fitzgerald, p. 76). Holland further alludes that the dominant individual typology indicates the attitudes and values the people express in their vocational environment (Leung, p. 118; Osipow & Fitzgerald, p. 76).

Super D. W's Self Concept Theory (SCT) postulates that career development and implementation are a person's self-concept process. SCT suggests that an individual's self-concept is a product of a complex interaction of factors including growth, personal experiences, and environmental characteristics and stimulations (p.120). SCT has been revised by other authors from Super's initial conception, and contemporary versions place more emphasis on social contexts including vocational maturity, language, stages of development, exploratory behaviour, and how these are reciprocated by their influence on people (P) and their environment (E) (p. 120). The fourth theory is Gottfredson's theory of Circumscription and Compromise (CC), which was proposed in 1981 and is also called Career Compromise theory. CC is designed around personal cognitive proficiency processes of evaluating appropriateness of occupational alternatives (p. 123). Gottfredson defines circumscription as a process of elimination based on self-concept and explains compromise as the attribute used to process the individual's compatibilities with external realities and constraints in order to maintain personal preferences for prestige and sex-type (p.124).

The fifth and final theory Leung writes on is the Social Cognitive Career Theory (SCCT), anchored on Bandura's self-efficacy theory. SCCT is a co-created reciprocal relationship construct between people (P) and environment (E) which is centered around the three core variables of self-efficacy, outcome expectations, and personal goals. Definitions of

what constitutes each of these three core variables of SCCT have morphed over the years (p. 125). However, it suggests a mutual influence between people (P) and environment (E) as the process of career development unfolds and indicates the relevance of time as a factor in this process (p.126).

While these theories are indicated for career development of adolescents into adulthood, they are relevant to this study as it references a period of career evolution and decision making resulting from processes of self-actualization. In addition, the stage in life of the participants and the international STEM PhD student is adulthood, further making these theories relevant for this study. Using CGT methodology for this study creates the opportunity to allow the organically emergent findings from the data analyses to be comparable to the career development theories for significance. The emergent theoretical model is used as a data source to determine its fit with these career development models, and the best fit is determined based on the described characteristics of this study's emerged theoretical model.

Chapter 3 – METHODOLOGY

In this chapter, focus is on discussing the general aim of my research methodology and explaining how it fits the purpose of the study. The discussion will indicate the pros and cons of my methodology and include references to prior literature. In addition, how this methodology was applied in this study, obstacles encountered and their resolutions, as well as observed biases will be elucidated alongside participants and participation analyses, ethics, empirical materials, and data. These will be explored to project the underlying research paradigm.

Researcher positionality

Research and its accompanying methodology of preference function like two sides of the same coin. An understanding of the researcher's paradigm indicates expected research methodologies that align with the paradigm's underpinning believes and values. Research methodology as explained by Mertens (2015, p.10) is a convergence of the researcher's axiology, ontology, and epistemology; helping the researcher determine how to obtain required knowledge and understanding. Research can be loosely or comprehensively defined depending on the author. Mertens (p. 2), indicates research "…is a process of systematic inquiry that is designed to collect, analyze, interpret and use data" to broaden human comprehension of various aspects and attributes of life, nature, or humanity. It can be said then that research is the formulation of questions, designing best approach to seek answers, managing various aspects of the journey to the answer, and making sense of it all. This is my pragmatic definition of research. It implies the dexterity of pragmatism to design the right approach to specific questions rather than forming the question and design to fit the researcher's paradigm. This view of what research is further implies non-commitment to either qualitative or quantitative study methodologies, and an ability to mix or adapt methods as deemed necessary for specific studies.

Often, I have reflected on my inability to see the world in stark black or white. I believe in the relativity of most concepts, truths, and values, as commonsensically deductible from an acknowledgement of the multi-faceted and multi-layered realities of our world. Personally, positioned by my life's journeys, I question empiricism and seek to understand underlying rationalizations, not from the ivory towers alone, but from every facet of society. This creates a consistent tension for me to adapt to other non-dexterous paradigms. My supposition that reality exceeds the realms of palpable, empirical, and logical explanations are grounded in my reality as a spiritually minded, heterosexual Yoruba Christian girl from West Africa. The combination of these descriptors as well as my life's journeys as a married mother of teenage children who is living like a single mother in pursuit of my life's academic ambitions place me into a more complex web of intersections. Being still happily married, my experiences, aspirations, views, and realities are unlike those of a typical married mother, or a married international student from my context. In addition, appreciation of the ability of a nation's immigration laws and policies to impact on family bonds, individual aspirations, and erode self-confidence, is part of my lived experience, which positions me differently from most people with whom I might share intersectional descriptors. Such positionality gives me the capability to delve beyond the existing reality in this study with an understanding of the dynamism of international context, language use, and contextual appreciation for participants and the data created.

Similar to renowned pragmatists like William James, John Dewey and Jane Addams, I see within this paradigm the requisite epistemology to drive social change by deducing what constitutes practical philosophies of the hegemonic moment and creating social awareness required to drive necessary societal policy changes (Morrison, 2016, p.298) necessary for attaining praxis. To this end, I eschew the relative boundaries created by most other paradigms as I want to have the flexibility to adapt my methodology to suit research intent, research question and obtain actionable research findings. Expectedly for this study I chose a methodology that

does not seek to castigate my involvedness in the research topic as a fellow international student at the same university as my participants, neither does it compel me to bracket my personal aspirations towards a doctorate program soon. Rather these are all elements of me that will reflect my creativity and reflexivity in inducing actionable and relevant theory/theories from the study.

In addition, as an international student, I have first-hand knowledge of the heterogeneity of this concept, how the Canadian immigration services as an example has widely varied rules, structures, and processes for students from different countries of origin, and how these all produce largely varying outplays of each student's experiences in their schools of choice. This makes a study of the international students' arena one with perceptible incommensurability of 'truths' (Mertens, p.37) which homogenize the realities of widely heterogenous concepts. Merging the experiences of Chinese or Indian students, who are already stereotyped into specific descriptor, with those of black African students whose experiences vary vastly, enables such homogenizations. Such summarizations form a forte for the pragmatist whose perception of the world is integrated with the variations of individual experiences. International students are directly fitted into this example of multiple realities.

Choosing Constructivist Grounded Theory

Having the understanding that the term International Student is deemed to represent institutionalized stereotypes that form insidious collectivism; a reductionist terminology hiding "seductive positivism" in the ivory towers (Montgomery, 2010), gives insight to the need for a methodology that allows the induction of multiple realities. Montgomery further explains the accuracy of a constructivist approach for research that seeks to understand international students (p. xiv). Johnston, et al, (2020) enunciate the necessity of a research methodology that makes

students active participants by curtailing the power imbalances when seeking to project student voices. Their paper validates constructing grounded theory as an apt research methodology because it enables theory development from participants own words expressions. Grounded theory further privileges students' perspectives and subjective experiences using inductive abstraction, giving adequate representation to student's voices (Johnston, p. 548-549). The process of constructing theory with the data is best suited for either researching new areas or reviewing viewpoints on familiar topics (Stern, 1980, p.21), with the latter being the case in this study.

Since the initial promulgation of Grounded theory methodology in the 1960's, it has undergone some 'restructuring' with non-positivist ontological researchers re-working it to include more contemporary perspectives as Constructivist Grounded Theory by Charmaz (2000) and Situational Analysis by Clarke (2005). Constructivist Grounded Theory relates conditions, perspectives, and interactions to how theory emerges (Charmaz, 2008, p.160). Specifically, Charmaz proposes an interactive exchange between participants and researchers by recognizing the co-creation of data rather than detachment in the data creation process (Adu, 2017; Bryant, p. 1). Constructivist Grounded Theory also "…assumes relativism of multiple social realities…" (Glaser, 2007, p.94) embodying the contextual heterogeneities international students portend. Co-creation of data within the constructivist paradigm inculcates the positionality of the researcher as the reviewer whose biases, though consciously bracketed, cannot be prevented from the interpretation of the data (Bryant, p. 3; Charmaz, 2008, p. 160; Glaser, p. 97). This is relevant accommodation for my positionality as an international student working on this research. Constructivist grounded theory approach stresses holistic understanding of context and rejects the possibility of reducing phenomena to their constituent parts, or measurements (Baum, 1995, 461). These all enable a broadness for the researcher's active involvement, alluding a recognition of the researcher's agency in the process, CGT thus strives for heightened accuracy.

Methodological Coherence

For this study, the methodological coherence results from the need to thoroughly understand the process of how international doctoral students perceive and engage with the cultures within their research groups, and what indications these have for their career trajectories, specifically in an entrepreneurial university. Generally, grounded theory is suitable for understanding underlying social processes associated with a phenomenon (Nagel, et al., 2015, p. 367). It is also important to appreciate the use of language by the participants knowing that international students are typically non-native English speakers or come from backgrounds where the English language has been adapted differently. Consequently, use of language also reflects the implied meanings deducible from the interactions with the participants, and its credence to understanding their spoken words. Constructivist grounded theory allows different ways of knowing and understanding with specific ethnographic leaning towards how language is used (Charmaz, 2015), requiring exploratory interview iterations in its data creation process (De Vreede, et al, 1999, in Bryant, 2003, p. 3). Such a process will be ideal to unpack any fluffy data resulting from the heterogeneity and intersectionalities of the students to clarify their responses and 'hear' the voices of the 'international student' in this study, making constructivist grounded theory a methodological fit.

Understanding that first, there are pluralities of interpretations arising from similar stimuli amongst people, and second, differing perceptions create plurality of meanings given to phenomenon, constructivist grounded theory's acceptance of subjectivity in the construction of knowledge adequately provides for a multicultural, heterogenous, and multi-ethnic socialization as that which exists in the STEM doctoral laboratories (Nagel, et al., p. 367). Additionally, constructivist grounded theory's inductive data analysis process unmasks insidious theoretical fixation that prescribes an expectation of theories (Charmaz, 2015), ensuring trustworthy

research outcomes. Allowing interview sessions to evolve organically is essential in the conduct of grounded theory, specifically for constructivist grounded theory, to enable participants to provide the responses that are most important to them. Constructivist grounded theory methodology thus relies on semi-structured interview questions which are allowed to grow organically as the sessions proceed. Whereas this study is aimed at theorizing about career trajectories, as constructivist grounded theory goes, the emergent theories might well extent into other areas (Charmaz, 2015; Morse, et al., 2002, p. 20). This richness serves well towards unbiased outcomes useable for policy prescription.

Application of methodology to Research Question

This study aims to give voices to international students to explain how they navigate the socialization and career processes while still within the system, thus giving appreciation for what factors are most impactful, how it impacted, and what evolutions they perceive themselves to experience and why. Focusing on students in year three and beyond in the STEM courses which are perceived to be more amenable to commercialization and entrepreneurship among university courses, participants have lived experiences of these factors and the perceived impact, while with the vantage of future contemplation.

Therefore, this paper seeks to understand students perspective of their research group culture's socialization process and lead scientist impact on their future career trajectory. The main question of study is to answer: '*How has the research laboratory culture impacted on their self-reported projected career trajectories as they proceed in their doctorate program?*' Accomplishing this with constructivist grounded theory methodology could produce answers to the following questions among other possibilities: a) How do laboratory group entrepreneurial cultures vary within the university's STEM departments? b) What variables do these international students adduce these variations to? c) How have these established laboratory

entrepreneurial cultures as perceived by the students impacted students' career identity, socialization and evolution? d) How do the students project these perceptions will impact their career decisions about their post-doc engagement? e) How strongly do they perceive their lead scientist's engagement culture on their personal planned trajectories? (f) What additional intersectional variables do they identify as most strongly significant in their decisions as international students, if any?

This study aims to amplify international students' own perceptions of what serves as impetus for their future career paths. To this end, career paths are divided into: (a) *Academia* – who aspire towards the traditional university research and teaching; (b) *Academic entrepreneurship* – who establish start-ups and collaborate with industry; (c) *Academic-industry collaborators* – who are receptive to collaborations with industry but do not intend to strike out on a complete entrepreneurial limb so maintain academic positions; (d) *Research industry/government employees* – who perceiving doctoral studies as additional preparation for employment aim to pivot their training towards preferred industry employment only; and (e) *(Non) Graduates* – this refers to individuals who decide either to discontinue their studies or not to take up any usual post-doctoral career, whatever their reasons.

Study design

This study is conducted using CGT which, in line with grounded theory methodology is an inductive methodology with the grand aim of theory building through emergent analyses of data co-created through symbolic interactionism (Goulding, 2002, p. 99; Nagel, et al., p. 367). Common to all grounded theory methods are theoretical sampling, constant comparison, coding, and memo writing (Nagel, p. 367). Grounded theory data is generated from discourse, gestures, expressions, and action information gathered through observation (Adu, 2015; Goulding, p.99). Data was created with international doctoral students in year three and above in their programs,

giving a minimum research laboratory experience of two years. The research population is set within the University of Alberta as a convenient study sample and participants are purposively selected among the international doctoral students in STEM programs in STEM and applied sciences. Diversity of the participant population was sought by extending recruitment opportunities to various faculties and departments in STEM and applied sciences to reach students in various levels of industry-engaged laboratories. Furthermore, theoretical sampling through iterative dwelling on participants responses was used to provide 'rich information' (Holt, et al., p.668). Specifically seeking to understand the diverse international doctoral student's embeddedness into their research group cultures in an era of globalized drive towards the *third mission*, an ideal method is required to tease out the nuances of the interacting contexts of this phenomenon.

Similar to Baum's (1995, p. 461) example between public health and medical science post1980s, the *third mission* agenda and its ramifications for STEM doctoral students are still evolving, hence the need for a "broadspectrum" method for "… probing beneath the surface … (and) …constructing abstract categories from data analysis" (Charmaz, p.161) for this study. Conducting a constructivist grounded theory study, a methodology that places emphasis on observing participants expressions, emotions, and gestures in the virtual space because of COVID-19 is limiting. Missing and not noticing facial expressions, eye-movements and such other data can deter from the rich data needed for the study analyses which could leave a data gap. To mitigate this possibility data creation in this study will be conducted in two ways.

Understanding the necessity of attaining saturation in the data creation process, the study is designed with the consciousness that 'data sufficiency or redundancy or adequacy' cannot be pre-empted, so saturation is directed more towards attainment of quality data that shows "…richness, depth, diversity and complexity…" (Fusch and Ness 2015, as cited by Braun & Clarke, 2019, p.2). Thus, search for saturation was noted but not utilized as a legitimizing

rhetoric in the pursuit of data creation (Braun & Clarke, p.6; Puddephatt, 2006, p. 17), and participants interviews were semi-structured, yet opportunity was given to reflect on responses given. In addition, noting the time frame set for the study report, interview questions were synthesized from prior responses for additional sessions with participants. Initial contact with potential participants through the recruitment documents synthesized them to the study methodology, initial one-on-one semi-structured virtual interview sessions, session iterations, and the focus group session. Based on responses received, five of the participants were further recruited for the focus group session to fill up gaps in initial analyses (Adu, 2015; Holt, et al., p. 669).

All sessions use codified names to preserve participants confidentiality and identities and are video recorded and transcribed using both ZOOM© and Otter © transcription apps. Transcriptions are merged and revised to capture both verbal and non-verbal communication inherent in participant's responses (Poland, 1995, p. 291), and fieldnotes are taken for each session. Analyses started immediately after the first interview sessions with open coding, proceeding through constant comparison analysis and theoretical sampling and eventually theory was formulated. Data was organized using NVivo®. Initial coding was done using line-by-line coding, focused coding techniques, and finally theoretical coding iteratively as data collection progressed (Adu, 2015; Gibbs, 2015).

Participant recruitment

Upon Research Ethics Board (REB) approval, the assistance of the relevant faculties and departments offering STEM related doctoral programs, as well as the graduate students' associations, departmental and university-wide, were contacted to solicit for participants at the University of Alberta. A total of 170 emails were sent to Principal Investigators (PIs) of laboratories in the applied sciences to solicit their support to gain access to their doctoral

students. Emailing information for the PIs were mostly garnered from available information on the University of Alberta website while a handful were from direct referrals by some of the 57 responses. Further to this, participant request adverts were also place in the weekly bulletins of the School of Public Health, Graduate Students Association, and the International Students association for 3 consecutive weeks in all instances in accordance with REB stipulations. Responses to the various forms of solicitations yielded results as eventual participants were recruited from the emails, adverts and snowballing from other participants.

A few initial respondents opted out due to the design of the study which required commitment to more than one interview session. Ten respondents filled out the online recruitment forms with a participant who neither chose participation dates nor responded to further communications. The tenth participant filled the online recruitment form, but the first session was missed due to time difference, after which the participant responded by opting out of the study. Overall, eight (8) participants were successfully recruited of whom seven (7) participants had three sessions of between 45 to 60 minutes of interviews, while a participant was available for only two (2) sessions. In summary, a total of 23 interview sessions were conducted, and a 1-hour focus group with five (5) of the participants. In grounded theory studies data from between 20-30 interview sessions are permissible (Creswell, 2007, p.67; Charmaz, 2006, p.41).

Participants were a diverse group of years 3 to 6 doctoral students within the University of Alberta's College of Natural and Applied Science. This college consists of the Agriculture, Life and Environmental Sciences, Engineering and Science faculties, who all started their programs as international students, reflecting diversity in race, gender, and immigration status. Of the eight participants, five identified as female and the other three, males. The participants comprised of one West African, three South Americans, one Easter European, an East Asian and a South-East Asian, offering a broad diversity of worldviews with only the West African

identifying with English as the first language. Represented are Spanish, Portuguese, Mandarin, Hindi, Serbian and Malayalam languages.

Among said participants, five had between 2 to 6 years of pre-doctoral education in English language, with the modal English language academic exposure being 2 years. Six of them confirmed they got information about and made first contact with their PIs via online platforms with one of them having completed their masters' studies under the supervision of the same PI, and the last participant was contacted directly by the current PI. Only one of the participants had identified as having a child among the two who had travelled to Canada with their spousal partners.

Data collection

Generally, Grounded Theory "…adventure starts … where we gather data" (Charmaz, 2006, p.13). Being an emergent method, Constructivist Grounded Theory (CGT), like its precursor, Grounded Theory (GT), "…starts with a systematic, inductive approach to collecting and analysing data to develop theoretical analyses." (Charmaz, 2008, p.155). CGT relates conditions, perspectives, and interactions to how theory emerges (Charmaz, 2008, p.160). Specifically, Charmaz proposes an interactive exchange between participants and researchers by recognizing the co-creation of data rather than detachment in the data creation process (Adu, 2017; Bryant, 1). CGT also "…assumes relativism of multiple social realities…" (Glaser, 2007, p.94) embodying the contextual heterogeneities international students portend. Co-creation of data within the constructivist paradigm inculcates the positionality of the researcher as the reviewer whose biases, though consciously bracketed, cannot be prevented from the interpretation of the data (Bryant, p. 3; Charmaz, 2008, p. 160; Glaser, p. 97). This is relevant accommodation for my positionality as an international student working on this research. CGT approach stresses holistic understanding of context and rejects the possibility of reducing

phenomena to their constituent parts, or measurements (Baum, 1995, 461). These all enable a broadness for the researcher's active involvement, alluding to a recognition of the researcher's agency in the process, CGT thus strives for heightened accuracy.

To construct 'Rich Data' that are "…detailed, focused and full" (Charmaz, 2006, p.14), data was collected using a combination of questionnaires, one-on-one interviews, and a focus group session in line with (Charmaz, 2006, p. 14; Creswell, 2007. p. 131). First a questionnaire to collect individual data such as age group, gender, marital status, year of study, region of origin (example West African, South American), and number of years of studies in English language was filled as part of the participants online recruitment. The questionnaire was also used to confirm comfortability with the use of a virtual platform for interviews, use of identification codes in lieu of actual names, commitment to three sessions of one-on-one virtual interviews, and interest in participation in the virtual focus group session. Three one-on-one semi-structured virtual interview sessions of at least 45 minutes each per session were conducted with all participants except participant 7 (P7) who became unavailable for the third and final session.

Unlike typical study design when constructing grounded theory, these interviews and eventual focus group sessions were conducted virtually via Zoom®, in observance of COVID-19 protocols (Cashwell, 2021, p.81; Costa & Schoales, 2022, p.5). While it may be argued that virtual interviews are contrary to the submersion into the interview environment preferred in Constructing Grounded Theory as noted by Costa & Schoales (p. 4), the COVID-19 pandemic required adjustments to the conduct of interviews and research methods (Costa & Schoales, p. 2). Using the Zoom online platform has proven convenient for participants, cost effective for the researchers, and enables participation across time zones, countries, and cultures (Costa & Schoales, p. 6). Working with a population experienced in virtual meetings effectively reduced the challenges stated by Costa & Schoales (p. 7) such as need for gatekeepers, technological assistance/training, provision of devices to participants in support of the study. However, such

other challenges as lack of intimacy with participants, technological glitches, inability to control participant's physical environment and presence of unsolicited audiences to the interview at participant's chosen location (Costa & Schoales, p. 7).

Specific experiences in this study included the inability to test compatibility of participant's devices with the interviewers, and disruptions from other occupants of the participants interview spaces. Another major challenge with this study was the inability to get an accurate transcription tool for the online interview space. Initial intent was to adopt Zoom's live transcription which failed due to the "accented-ness" of both participants and interviewer. The move to Otter was a progression from the challenges of Zoom but did not eradicate mis-transcriptions with such transcriptions errors as shown below -

- "Iraqi toast" instead of "Hierarchical";
- "very mature ethical model and Viagra" instead of "A more theoretical modelling background";
- "Moines our loss it sounds this an international students to treasuries and Canadians" instead of More is, about 70% international students to 30% Canadians"
- "So my guess would more cages range" instead of "Some are just with more PhD students than the others"; and
- "Malaysian funding" instead of "managing the funding".

These hilarious examples are only picked from participants transcripts, they do not include the plentiful erroneous transcriptions of the interviewer's questions.

A peculiar technological challenge encountered was the instance of P2 who's computer and earphone/earpiece somehow distorted the audio in the Zoom video recordings, creating a transcription bottleneck that lasted for weeks. Being an amateur qualitative researcher, this created a transcription backup that occasioned in delays in the transcription of sessions with

other participants. Dealing with the transcription delay and knowing the succession of participants chosen interview schedule meant I resorted to using the responses and codes formed from P1's (participant 1, session 1) transcript, the video recordings were used to find emergent themes. Doing this involved constantly reviewing the videos of past interview sessions with participants, reviewing notes and questions and responses of previous participants. Overall, five of the recordings, the three sessions with P2, as well as major sections of the first session with P1, and second session with P3, had to be practically re-transcribed due to the accented-ness of the participant which though was clear to me during the interviews, was terribly transcribed by the automatic transcription devices, and the recordings were distorted for reasons unknown.

Rich data collection of thick descriptions to ensure the richness of the data constructed was further accomplished by writing interview memos (Charmaz, 2006, p.14). Grounded theory methodology affords researchers the flexibility of adapting their methodology as deemed necessary for the research outcome (Charmaz, 2006, p.14; Johnston, et al, 2020). Understanding the "… tensions between international students being a strong social group yet also retaining their independence, …wish(ing) to develop profound relationships with home students yet still retaining some fears and preconceptions …, emphasize the complexity of the social and cultural context" (Montgomery, 2010, p.xvii) reflects some of the contextual variables considered in the design of the study and choice of methodology. Structuring the study to request participants for second and third interviews was deemed necessary to address stereotypically induced interpretations in data analysis (Heater, 2021, p.78). Setting up these additional iteration sessions permitted member checking to fill up gaps in initial analyses by seeking further insight into previous data (Adu, 2015; Charmaz, 2006, p.111; Holt, et al., p. 669). At the conclusion of one-on-one interviews, participants who had identified their interest in a focus group session were invited into a virtual session in which five people participated. A one-hour focus group was conducted with five of the participants in attendance as further member checking, and in lieu of

laboratory observation. These adaptations in study data creation methodology conforms with CGT's logic and theoretical sampling (Charmaz, 2006, p. 16; Creswell, 2007, p.128).

Participant population sample anticipated for data creation in this study was fifteen to twenty-five doctoral students in years 3 or 4 of their program, to ensure data saturation. However, the end limit of year 4 was extended to accommodate all STEM PhD students who commenced their studies as international students, irrespective of whether their immigration status has changed to permanent residents (PR), or not. Utilizing such criteria extension ensured the sample accommodated all the people who are useful to the study as prescribed by CGT to establish necessary sample criteria (Mayan, 2019, p. 79). Students in this bracket have had at least 2 years lived experiences in their respective laboratories as doctoral students and are able to provide 'rich information' (Holt, et al., p. 668; Mayan, 2019, p. 79).

Participants P1 and P2 were both engineering students and neither identified as first language English speakers, nor was either married or in a committed relationship. Other participants included one male and one female who are married, one with child and the other not, non-engineering STEM doctoral students, two participants who had no prior English language instructed studies prior to their PhD, and two who had all prior education in English. Such heterogeneity in contextual backgrounds, the iterative interviewing and focus group session fostered theoretical sampling to address the emerging theories (Charmaz, 2006, p. 96; Charmaz, 2008, p. 166; Creswell, 2007, p. 64; Mayan, 2019, p. 82).

Data generation included interviews and focus groups, and saturation was accomplished when no new findings emerged. Interview data was analysed from individual interviews to examine contexts. Further, focus group was conducted to enable further examination of emergent themes to validate findings in line with Morse, et al., (p. 20). Though I acknowledge the likelihood of tedium arising from analysis, methodological error, and the possibility for non-

generalizability in the constructivist grounded theory method, working with my supervisor and an experienced qualitative researcher assisted in limiting these challenges (El Hussien, et al., 2014, p. 5).

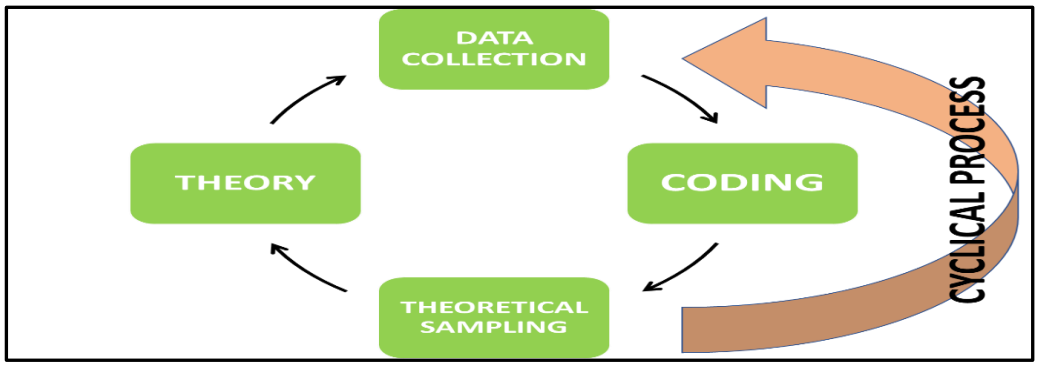
Coding

Charmaz (2006, p. 46) explains coding in Constructivist Grounded Theory as "…the pivotal link between collecting data and developing emergent theory to explain … data." Further explained generically for qualitative research, Saldana (2008, p. 3) tells us a code "…is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data." Coding then translates to a congregation of thoughts, emotions, and expressions summarily to depict researchers' perception. Specifically in CGT, a code serves as the verbal organic expression of participants language, expressions and emotions captured in their statements. It represents the researcher's reflection on the participants conveyance of their lived experiences to create codes which are woven into categories and finally used to establish a theory. Codes can summarize or condense and describe data, transitioning them to build theory follows a non-linear procedure as depicted below (Fig. 3) (Charmaz, 2006, 46; Creswell, 2007, 64; Heater, 2021, p.84; Saldana, p. 4). In constructivist grounded theory coding considers the languages, meanings and perspectives of the participants while acknowledging the active involvement of researcher's perceptions. (Charmaz, 2006, p.47). Coding in CGT can be broadly categorized into initial, focused, and theoretical coding applied in a back-and-forth process (Charmaz, 2006, p. 24; Creswell, 2007, p. 64; Heater, 2021, p.84).

Initial coding requires researcher to use the available data to answer questions about the data that identify topic of inquiry, perspective of response and respondent, and the implication of these responses within the theoretical context of inquiry (Charmaz, p. 47). Initial codes are

"…provisional, comparative and grounded in data" (Charmaz, p. 48), often using language from the actual data. In the study, the initial coding consisted mostly of line-by-line coding and a few instances of sentence-by-sentence coding where it was deemed necessary. Codes including 'Making friends with classmates', 'Contrasting Cultures', 'Defining better opportunities', 'Building job aspirations' and 'Defining better opportunities. These gave direction to questions asked at subsequent sessions, especially in the light of the transcription challenges that occurred. Using the initial codes as my base, I watched and rewatched recorded videos to facilitate study continuation while resolving transcription challenges.

Figure 3 - Grounded Theory Iteration Cycle



Axial coding shows how subcategories become or are formed into categories by specifying the properties and dimensions of the category, and coherently reassembles data fractured during the initial coding process (Charmaz, 2006, p. 60). Axial coding helps to convert data into concepts that aim to show the relationships between categories and subcategories, and explain why they are linked (Charmaz, p. 61). Doing this uses actions/interactions to answer questions about whom and how questions; understand the conditions to answer why, where, how come, and when questions; and consequences to understand what happened (Charmaz, p. 61). During this phase such codes as 'Thinking career trajectories' became a category with sub-

categories ‘looking to learn and grow’, ‘describing nice jobs or better opportunities’ and ‘career preference’. Hearing participants talk about how they were considering what characteristics they consider as good when assessing jobs with different expressions, acknowledging that what they were saying in all the different forms was describing how they think about career trajectories.

Ethical Considerations

This study involves human subjects and is consequently required to follow the Tri-Council Policy Statement of Ethical Conduct for Research Involving Humans (TCPS2 2018). In accordance with the directives of this policy, the research must maintain fairness, equity, privacy, and confidentiality of participants throughout. Ethics approval was obtained from the University of Alberta for human study via the Alberta Research Information Serves (ARISE) online platform. The application process involved enumerating detailed research paradigm, procedure, activities, and participation expected to be carried out during the study. Some of the documents submitted for the ethics application were copies of the confidentiality agreement, REB consent letter, Participant information letter, and Questionnaire with possible open-ended questions, all of which were approved. The Research Ethics Board (REB) approval number is Pro117497 (See Appendix 1). The approval was to ensure participation was voluntary, participants could withdraw at will, participants were made aware of possible recourse and sources of assistance available in the university, and their participation and responses were anonymized.

An inherent risk in this study was ensuring confidentiality of the information given by participants as they reflect on and discuss their perceptions of their colleagues and professors - members of their laboratory group. Individual participants signed confidentiality and approval contracts pre-study to give them a detailed understanding of expectations, scope, and purpose of the study, as well as responsibilities of both participants and researcher(s) and matters of

confidentiality. Participants confidentiality was protected by giving participants codified names for the Zoom interview and focus group sessions. This situation required ensuring participants are comfortable during the interview, that as a researcher I exhibit constant creativity, reflexivity, and sensitivity during and after sessions, while memoing my thoughts and maintaining my fieldnotes. Although the interviews were conducted virtually rather than onsite as prescribed by CGT, it remains imperative to maintain the comfortability of participants by acknowledging the sensitivity and emotionality of the experiences they may have to relive. Contact list of relevant University of Alberta resources for mental health and any other possible trauma was available for participant, they were notified about the availability, and for those who requested it.

Participants were encouraged to determine the space and time for their personal interview sessions, and latitude was given to prematurely terminate sessions if requested by participants for any reasons. Code names were given to participants, and additional identifiers such as courses of study were maintained at the faculty or school levels to further minimize identification. Once transcribed, original video recordings will be securely filed away, and only principal investigator will be able to access them, and they will be destroyed after publication and peer review of final report or 5 years after study. Overall, every effort will be employed to maintain the core principles of TCPS2 (p. 6) of Respect for Persons; Concern for Welfare and Justice.

Other Ethical risks

Other ethical risks envisaged in this study were (i) risk to participate, (ii) risk to the environment, (iii) risk to relationship, (iv) risk to researcher, (v) risk to topic and (vi) risk to outcome. *Risk to participate* involves ensuring participants' comfortability and trust. To mitigate this, participants' comfortability with topic, questions, interview, and the process was ensured.

Anonymity, confidentiality, and liberty to decline answering questions or discontinue participation was communicated to all participants. The precarity of internet connections ranging from visual and audio disruptions to inability to connect are the main *risks of the technology/environment* in the virtual space. An additional risk was that of possible disruptions arising from where participant chose as interview location. *Risk of relationship* is about perceptions of power which is mitigated by ensuring a conversational informal ambiance during sessions to facilitate balanced power relation in the study. The *risk to me as the researcher* in this virtual study is about me getting emotionally charged because of my aspiration towards doctoral studies. Maintaining reflexivity and sensitivity through memoing, field notes, and member check mitigates this. Participants perception of *Risk of topic,* especially in the likelihood of a leakage of their transcripts is curbed using confidentiality agreements, anonymization of participants, security of original recordings, and ability to withdraw or decline questions. The *Risk of outcome* of the study discovering unexpected outcomes which could change the topic of the study completely. Adoption of triangulation, reflexive memoing and audit trail help to validate outcomes.

Questionnaire

Upon receipt of show of interest emails, interested persons were sent a google form questionnaire consisting of preliminary questions. The questionnaire was in sections made up as follows:-

- General demographic questions covering year of study, age, gender, region of origin, first language and years of English language study.
- Personal circumstances identifier covering experiences outside home country, exposure to supervisor and Canada, and familial connections.

- Study Information and instructions covering participation in focus group session, and focus group structure preference, comfortability with zoom and codified names, recording, and choice of interview dates and times.
- Consent form in accordance with University REB guidelines.

Interviews protocol and procedure

After participants submitted their initial questionnaires, interviews were conducted on zoom at time and date as requested by participants. For each participant, their names were codified to ensure confidentiality, some of which were P1-CME, P2-EEE, P3-BSC, among others. Each interview session was billed for 45 minutes each, but a few ran up to 60 minutes with participants' consent. Each participant had signed up for three sessions in accordance with Charmaz prescription of a need to reinterview or revisit sites for grounded theory (2006, p. 111). Each session with a new participant resumed with reiteration of information about the study, the assurance of confidentiality and the available resources by the university of Alberta in the event of any trauma arising from the session. These were abridged and repeated for all other sessions. Participants were also assured of their liberty to skip questions or pull out from the study.

All first sessions started with the question about why participants chose to study for their PhD, their expected career afterwards at the point of admission. Depending on the responses, further questions were asked to understand the trajectory of their career expectations at the point of interview. Other questions asked during the interviews include the structure, culture and leadership of their laboratories, engagement with industry, government and academia, views and opinions about how and what the impact of their international student status means. During the interviews, other questions arose concerning mentorship in the laboratories, individual interpretations of terms like entrepreneurship, culture, and mentorship, and on issues around immigration, in line with theoretical sampling.

With most participants, questions and responses covered all elements on the pre-set questions, though deviations were often deemed necessary to pry further into certain responses in line with theoretical sampling principles. After the first interview with participant P1-CME, questions for other sessions, including sessions with new participants, were rigged in line with responses already given by same or other participants in prior sessions (Charmaz, 2006). Every session was recorded in video and transcribed using the automatic transcription apps Zoom and Otter, but were checked and corrected by the researcher.

Rigor - Credibility, Transferability, Dependability, And Confirmability.

Throughout the research process rigor was upheld through continuous reflexivity (Bradbury-Jones, 2007, p. 291). Rigor, also sometimes called credibility, transferability, or dependability, is defined as criteria for judging trustworthiness of a study (Bradbury-Jones, p.291). The accuracy of interview and focus groups transcripts was ensured by the researcher (Adu, 2015; Poland, 1995). Furthermore, CGT "…acknowledges researchers' paradigmatic orientation and experience…" through reflexivity (Nagel, et al., 2015, p. 368). This is why conscientious efforts towards maintaining a reflexive memo alongside my memo writing was done to inculcate my subjectivity in the study. The reflective memoing explored aspects of my intersectionalities as a researcher, and situated me during the data creation, coding, or analyses processes. This formed a part of the audit trail for my final report because it explains the rationale behind decisions made in the analysis process of the study (Bradbury-Jones, p. 291).

Member-checking by reflexively revisiting participants questions for further elucidation on responses to accomplish rigor for deep knowledge co-creation (Nagel, et al., p. 375) was consistent throughout the study. Furthermore, video recordings, prolonged engagement through multiple sessions, engagement in a focus group session comprising some of the participants in lieu of observations, maintenance of fieldnotes and reflexivity memos for audit trails, and

triangulation were additional strategies to ensure rigor. Member checking was further conducted through the conduct of a focus group session where the responses from previous interview sessions were the bases of further questions to a larger number of participants at once.

Anticipated Outcomes and Knowledge Transfer

Smirnova, Y.V. (2014, p. 3) explicates "knowledge transfer" as a purposeful or consequential effort that involves transmission of information and ideas between parties through a socialization and cultural exchange process. Understanding the unique need for convergent appreciation of the "knowledge" to be transferred, this will be structured in line with Smirnova's (2014) suggestion at three levels: individual, intraorganizational, and inter-organizational.

An in-depth understanding of the socialization process of doctoral students requires appreciation for and relating with their perspectives of how the research laboratory cultures impact their eventual career choices. Further actualization of the *Third mission* agenda in the contemporary entrepreneurial university systems will be effectuated to the extent to which senior researchers, professors and faculties understand the ideation process of students, and the indications of specific laboratory cultures. This might enable a better ability to 'fit' students with or into research laboratories in STEM programs, and by extension create a renewed trend in the socialization culture in doctoral programs generally. In addition to these, this study aims to establish an avenue for doctoral students to 'find expression' about their varied perceptions of engendered practices in the entrepreneurial university agenda, indicating possible sources of such diversities, possibly lowering the doctoral students' attrition rate.

This study's findings will be transferred at each of the three levels iterated below as follows (Smirnova, p.3):

Table 2 - Knowledge Transfer Plan

Knowledge Transfer KT	**Involved parties**	**Who and How to involve**
Individual KT	peers, friends and acquaintances	Professors, Lead scientists, Individual Faculty members
Intra-organizational KT	within one organizational setting (e.g. department, division, organization or university)	Research Laboratories, Departments, Schools, and Departmental Associations and groups
Inter-organizational KT	Cross-organizational learning	Universities, Conferences, Policy makers

The KT approach will engage with the University of Alberta and faculties of science, engineering, and graduate studies to create access for eventual knowledge transfer for our findings. Opportunities for seminars, meetings, and presentations will be sought with faculties, staff, and students to showcase our research findings. Students' organizations and associations create additional 'safe spaces' to present the findings to students, so opportunities will also be sought with the STEM/applied sciences graduate (doctoral) students' associations at departmental, faculty, and departmental levels. Possibly creating avenues to relate outcomes with international students' associations to facilitate orientating new students into the doctoral socialization cultures will be sought.

In line with Levin (2008), the objective here is to eventually affect policy through the change of 'daily practices' of ideas and behaviours; using personal contact and interactions to elicit two-way use of the knowledge created; ultimately effecting policy decisions within the complex institution of the university. As the *third mission* agenda continues to create more entrepreneurial leanings for universities, greater cognition of the various layers of the university is required to facilitate this transition particularly with respect to the international students in

STEM and applied sciences. Consequently, efforts will be made to present this study outcome at conferences, and publication of the article in a recognized journal to add to extant pedagogy on the entrepreneurial university.

Findings and coding outcomes

The outcome of this study is derived from the analysis of the participants responses by using their own words to express their perceptions about the things that guide their thoughts as they proceed towards career realization. The Constructivist Grounded Theory methodology produced a theoretical model centered on social expectations as the major determinant of how international STEM PhD students gravitate towards their postgraduation career choices. The social expectations are built from the academic expectations ingrained into them through their academic socialization process within their research laboratory, while familial expectations are a result of the individual student's context, intersectionalities and familial circumstances. Some of these familial expectations and their implications on career decisions will vary among individual international students depending on several contextual intersectionalities. The effect these familial expectations have on international students are different from those of Canadian students owing to several contextual differences.

Defining and processing their social expectations propels international students towards their choice of ambitions rather than specific aspirations. Availability of opportunities, weighed by the degree of academic versus familial expectations determine the international students' ambitions as many are compelled to consider implications of their career choices on their circumstances rather than considering pure ambitions.

Respondents

There were eight respondents who were all past year two of their PhD studies. One participant was in year 6, two in year 4, and the remaining five were in year 3 of their respective programs. There were five females, two of whom were aged 20-30 and the other three 31-40, while the other three identified as males, one aged 20 – 30, and the other two 31- 40. These participants were from various regions of the world, three South Americans, one Eastern European, one West African, one East Asian, one South East Asian, and one South Asian. Amongst them were two who had transitioned while in their graduate program into their PhD, one who had 4 years and all the others had 2 years of master's studies before their PhD studies. Most interview sessions were about 50 minutes, but a few went up to 60 minutes.

Table 3 – Basic Identification Information of Participants

Descriptor	PhD Study year	Gender	Age:	Dept of study	Geographical region of origin	How many years of graduate education did you have before your PhD?	First language
P1-CME	6	Female	31 - 40	CM	South American	2	Spanish
P2-EEE	3	Male	20 - 30	EE	South Asian	2	Malayalam
P3-BSC	3	Female	31 - 40	BS	Eastern European	4	Serbian

P4-CME	4	Female	20 - 30	CE	South East Asia	0	Hindi
P5-BSC	3	Male	31 - 40	BS	South America	0	Portuguese
P6-CHE	3	Female	20 - 30	CH	East asian	2	Mandarin
P7-MCE	4	Female	31 - 40	ME	South America	2	Spanish
P8-MCE	3	Male	31 - 40	ME	West African	2.5	English

Initial coding

The data collected from the interviews and focus group sessions resulted in almost 10,000 lines of text. Using line-by-line coding on the overall data produced by the first 5 interviews produced 249 codes overall. Excerpts of the basic final statements are in Appendix 6 with the codes they generated. More specific codes were generated through constant review and consolidation of the codes while seeking to answer the questions about the conditions, actions, and outcomes, fifty five (55) codes emerged from the initial codes as shown in table 5 below. These codes were not simply a result of frequency but also a reflection on the researcher's perception of participants circumstances, responses, and the interpretation of their actions.

Table 4 – List of initial 55 Codes

Initial codes	
Activities during PhD	Feeling about PhD decision
Adjusting to Canadian environment	Feelings about entrepreneurship
Affirming PI's research influence	Individualizing student outcomes
Articulating PhD engagment expectations	Internationalizing access to information
Awareness of University resources	Internationalizing career trajectory thoughts
Career preference	Internationalizing the PhD Experience
Challenging relations with people abroad	Intersecting marriage, children and studies for international stud
Communicating in lab	Lab Community
Communicating intersectionalities	Lab leadership
Communicating, informing and assisting students by the university	Lab structure
Comparing collaborations within the Helix	Laboratory culture
Concerning immigration	Looking to learn and grow
Concerning university and departmental impact on career thought	Noting Canadian academic and cutural diversity
Confirming motivation	Personal value influencing actions
Contextual background	Personalising internationalness in personal context
Contextualizing pre-PhD experiences	PI creating opportunity and environment
Contrasting cultures	Recognizing language issues, internationalness and context
Dealing during COVID	Reflecting about lab
Deciding why PhD	Reflecting on COVID 19 pandemic
Defining Mentorship	Reflecting on self context
Denoting personal differences	Reflecting on why PhD
Describing nice jobs or better oppotunities	Role modelling own supervisor
Describing the use of personal agency	Situating PI's past experiences
Engaging with academia	Supervisor has impact on career path
Engaging with government	Tapping student agency
Engaging with industry	Thinking career trajectories
	University aiding students
Expressing most pertinent concern	Working the Triple Helix

Axial coding

Axial coding is used to "…sort, synthesize, and organize large amounts of data and reassemble them in new ways after open coding" (Charmaz, p. 60). It is used to answer the "…when, why, where, who, how, and with what consequences" by building relationships around the axis of a category (Charmaz, p.60). As a result of reviewing and constant comparison using axial coding, of the 55 initial codes, 11 codes emerged based on their conceptual relationships to form conceptual categories. These 11 emergent categories are in the table 6 below. Continuing constant comparison and review of the 11 conceptual categories, four groups of categorizations emerged. These groups are 'experience', 'career thoughts', 'students intersectionality' and

'supervisor impact'. These categories are presented in tables 7, 8, 9, 10, and 11 below to explain the coding flow and analysis.

Table 5 – List of 11 Focused Codes and their Conceptual Categories

11 Axial focused code	Tag	Conceptual codes
Working the Triple Helix Adjusting to Canadian environment	1	Experience
University aiding students Thinking career trajectories Internationalizing the PhD Experience Feeling about PhD decision	2	Career thoughts
Reflecting on COVID 19 pandemic Reflecting on self context Tapping student agency	3	Students intersectionality
Supervisor has impact on career path Laboratory culture	4	Supervisor impact

Conceptual code - Experience

The second code of 'adjusting to Canadian environment' encompasses international STEM PhD students experiences in adjusting to the Canadian environment. This code consists of their opinions of the Canadian environment, the issues and challenges with immigration and the limitations of the same, the diversity, exclusions, inclusion and integration into the Canadian academic, social and community cultures. See table 8.

Table 6 – List Of Properties of The Experience Conceptual Code

Codes		2 codes (of 11)
Working the Triple Helix	1	Working the Triple Helix
Comparing collaborations within the Helix		
Engaging with academia		
Engaging with government		
Engaging with industry		
Feelings about entrepreneurship		
Adjusting to Canadian environment	2	Adjusting to Canadian environment
Noting Canadian academic and cutural diversity		
Contrasting cultures		
Concerning immigration		
Challenging relations with people abroad		

Conceptual code of 'Career thoughts'

This category consists of codes 'university aiding students', 'thinking career trajectories', 'internationalizing the PhD experience' and 'feeling about PhD decision'. Perceptions about the success or failure, absence or presence, and availability of information and resources, were converged here. Desired factors and descriptions in preferred jobs is part of this emergent code, alongside uncertainties, transitioning thoughts and explanations about career preferences, nice jobs and better opportunities are further converged here. This code also consists of how students expressions portray their thoughts as international students in the STEM PhD programme.

'University aiding students' is a reflection of how, where and when international students are aware of, access and find efficient, the university's resources especially for career guidance, departmental and faculty efforts, and reception for aids and resources for students. Communication efficacies and methods are also reflected upon at the university, faculty, and departmental levels. Consequently, this code weighted in on the impact university resources, activities and resources are perceived to make on the career thoughts and perceptions of international students.

The code 'thinking career trajectories' reflect the evolution of international students' thoughts with respect to their post graduation career from their pre-doctoral opinions. The descriptors, values, cultures, and expectations of what constitutes a fitting career choice is

expressed in relation to students' preferences. The desire about growth and learning, and what this means is further expressed here. This code also converges specifics of what international STEM students consider relevant in thinking career.

As international students, the code 'internationalizing the PhD experience' reflects the students' expressions about how the status or identifier as "international students" mean in their experiences in the doctoral programme. Language issues such as expressions, accented-ness, expressions, reactions and responses are also portrayed, while considering matters concerning student's marital status as well as parenthood for international students. Pertinent concerns for international students are also expressed and how these affect the students.

Overall, this code is a sum of other thoughts, ideas and 'feelings about PhD decision' as students contemplated their thoughts about their programmes, their activities non-academic and extra curricular activities during their programmes. Expectations about engagement during the programme, factors and circumstances of engagement, details and outcomes about expectations are also portrayed. Principal factors that led to taking a doctoral position, and reflections about why they are in their programmes come up here.

Table 7 – List of the Properties of the Conceptual Code University Aiding Students

Codes		4 codes (of 11)
University aiding students	1	University aiding students
Awareness of University resources		
Communicating, informing and assisting students by the university		
Concerning university and departmental impact on career thought		
Thinking career trajectories	2	Thinking Career trajectories
Career preference		
Describing nice jobs or better oppotunities		
Internationalizing career trajectory thoughts		
Looking to learn and grow		
Internationalizing the PhD Experience	3	Internationalizing the PhD Experience
Recognizing language issues, internationalness and context		
Personalising internationalness in personal context		
Intersecting marriage, children and studies for international studer		
Internationalizing access to information		
Expressing most pertinent concern		
Feeling about PhD decision	4	Feeling about PhD decision
Activities during PhD		
Articulating PhD engagment expectations		
Deciding why PhD		
Reflecting on why PhD		

Students intersectionalities

Codes that converge under this emergent code are ‘reflecting on COVID-19 pandemic’, reflecting on self context’ and ‘tapping student agency’. Under this code how, where and when students felt the need, or were compelled to deploy personal agency in their laboratory or PhD experiences, and personality differences and outcomes. In addition to these are reflections on personal journeys into the PhD programme such as reflections from pre-PhD experiences, expectations, cultural values and experiences that formed their mindsets when coming into their programmes, as well as factors that motivate their activities as PhD students converge here. Expressions of lived experiences, cultural differences, language and accented-ness, home country circumstances, living in other countries prior to the PhD programme, and reflections on the effect of being international students on PhD programmes are converged in this code.

Table 8 – List of the Properties of Students Intersectionality Conceptual Code

Codes		3 Codes (of 11)
Reflecting on COVID 19 pandemic Dealing during COVID	1	Reflecting on Covid-19 pandemic
Reflecting on self context Communicating intersectionalities Contextual background Contextualizing pre-PhD experiences Personal value influencing actions	2	Ref;ecting on self context
Tapping student agency Confirming motivation Denoting personal differences Describing the use of personal agency Individualizing student outcomes	3	Tapping student agency

The code ‘reflecting on COVID-19 pandemic’ reflects the impact of the pandemic and the shifts it had on international students’ experiences, perceptions, health, finances and the implications on their expectations, attitudes, and reflections about their future. Table 10 presents a list of the components of this code, ‘reflecting on self context’, reflects expressions about gender differences, personality differences, student’s stage of life, cultural background, specific experiences, personal and cultural values, previous relationships, and friendships, and how these influences are relevant to the international students and their outlook. In addition, ‘tapping student agency’ reflects international students’ perceptions of other students, their motivation, expected and actual individual student outcomes, work expertise and responsibilities, personal differences, and capacity to deploy personal agency.

Supervisor impact

This is an emergent code from the codes ‘Supervisor has impact on career path’ and ‘laboratory culture’. The support, structure, leadership, relationships within laboratory, role modelling and guidance, mentorship and communication are reflected here. The effects of an entrepreneurial supervisor, supervisor’s past, support systems in laboratories, and what, who and how research is influenced, and perceptions on culture are reflected under this emergent code. ‘Laboratory culture’ is a code reflecting communicating in the laboratory, how its done, the

bonds it forms, and the cross-cultural implications and experiences of communication. Mentoring within the laboratories, students opinions of who and how they are mentored and perceptions of its efficiency or inefficiency are also converged in this code.

Table 9 – List of properties of the Conceptual Code Supervisor Impact

Codes		2 Codes (of 11)
Supervisor has impact on career path	1	Supervisor has impact on career path
Situating PI's past experiences		
Role modelling own supervisor		
PI creating opportunity and environment		
Affirming PI's research influence		
Laboratory culture	2	Laboratory culture
Communicating in lab		
Defining Mentorship		
Lab Community		
Lab leadership		
Lab structure		
Reflecting about lab		

Categorising the focused codes

While engaging in focused coding, multiple passes of reviewing, categorising and reassembling the focused codes were conducted to develop the conceptual categories. Further reflections on and interaction with the four conceptual codes and sifting through the initial codes to make analytical sense of the data revealed deeper interpretations to the data and highlighted how some of the focused codes gave meaning and depth to other codes. Sample of the memo reflecting the thoughts arising from the codes is presented in Appendix 8 elucidating each of the four conceptual categories in details below, and a sample of the definition of the experience conceptual category is given in the table 12 immediately below.

Table 10 – Sample Reflexive Memo on Conceptual Categories

Working the Triple Helix	1	Experience	What students experience or hope to experience when they engage with the various sectors of the triple helix is formative. They experience what they are exposed to, what they are exposed to within their labs for the roots of their perceptions and often they have no means of checking whether or not these perceptions are right. These experiences become a form of 'conditioning' of students' minds. The degree and specifics of engagement creates a mental map for their own expectations beyond which they are unlikely to attempt. Although these exposures do not determine they will fully extent themselves within the perceived scope, it means they may become inured to possibilities outside this pre-set scope. These experiences cordon off their expectations towards future career possibilities. There is a process that sort of 'others' and excludes options for students such that unless they have equally experienced other possibilities, personally or through the knowledge of others who have, they are unaware. The exclusion is a reason why many are unaware of the university's TTO and entrepreneurial resources - their labs do not indulge in such; they have no need to access the resources even if they were aware. This is why experiences denote expectations in my mind. As international students, their experiences from their laboratory's socialization efforts forms their network of prospects, whether as mentors, employers or colleagues. Hearing some participants unable to connect how their work could relate with government, no knowledge of processes, or opportunity for entrepreneurship all portend a gap in STEM and Applied sciences students' exposure to the third mission in an entrepreneurial university such as the UofA.
Adjusting to Canadian environment			

Defining the conceptual code of Experience

The first conceptual code is 'experience' and it is related to the experiences of international STEM PhD students in transitioning and fitting into the Canadian environment. As newcomers into the country and into their roles in the academic environment, students expressed feeling excitement, differences, uncertainty, struggles and caution as they entered the Canadian environment.

Working the triple helix

The first code under this conceptual category, 'working the triple helix', is a collage of how these students experience the helix. Working the helix relates with the experiences about, within, and contrived about working in academia, industry and government, as well as the

particular focus of the third mission, entrepreneurship and startups. The outcome of these engagements are cogent factors in experience formation of students. Experiencing how collaborations work within and among university, industry, and government was considered as:

"So I do think that there is slight gap here (referring to research expectations)*, like between a basic science or academia and industry and Applied Science. And I think that the reason for that is the lack of communication between two branches, which I've been trying to break, I do think that we need to understand each other better. But one of the main problems is that sometimes people who are more in academia have a hard time explaining to people who stakeholders are, who actually give you money, …"*

In comparing relating with people in industry with academia, students' perceptions about how forming relationships feed off engagement types are relevant to these experiences:

"… in my experience, at least, maybe in other people's experience, it's different, where it's just more about the project you're working on. So if you're working on the application, it's more likely you will meet the industry people. If you're working on science, it's less of a possibility unless er, like your professor has a company of his own where you can meet clients." (P4-S3)

Collaborating experiences and the confidence resulting from positive experiences are noted: "*It is pretty nice. My experience and my labmates experience, they're all pretty nice. They're, all those collaborators, they're nicer than my supervisor, so no complaints. Laughter."* (P6-S3)

Students' opinions about government engagement were contained in the perceptions about how these engagement are experienced as international students or as permanent residents (PR) or Canadian students: "*I could work for the government, I can work for both provincial and federal governments I can apply for, if I want it, and I could apply for NSERC … so I think it's one of the biggest source of funding for science. You can only apply for those if you're a*

permanent resident. So international students can't apply for those. And in some cases, a PI might already have the funding but they can only employ students that are permanent residents … or are Canadians. So internationals just like kind of like left aside for that source of … funding. As a PR I don't have to worry about those anymore. I'm pretty much, pretty much a Canadian (chuckles), at least in the in the eyes of the law." (P5-S2)

Engagement with academia stems from experiences curated within the scope of the study programme as it extends into socialization within and without the academia:

"*But one of the main problems is that sometimes people who are more in academia have a hard time explaining to people who are stakeholders, who actually give you money, so you have to figure (sways from side to side with a slight smile) out that it's important for people who give you money to understand why do you need money for so you can say I need money because I want to play with something, No, you … there must be good justification. So really, we need from our side we need to learn how to communicate our science and our goals better*" (P3-S1)

Experiences garnered by international students during their study, either personal or learnt from others, play a significant role in the code 'adjusting to the Canadian environment'. Addressing initial fit into the country, students bring up reflections on first experiences: "*Yeah, so when you move to a new country, you basically don't know anyone. I mean, there's probably some lucky people that know a few er people that are here or that came with them, but I think most likely you don't know anyone."* (P1-S3).

Integrating into the community outside and within the laboratory held a variety of experiences for students: "*It was easy, (still smiling). That was very easy* (referring to main supervisor's group) *… I was a little hesitant at first because I didn't know anyone, but I think … it took me a long time to fit into the group* (referring to co-supervisor's group) *… I used to just sit quietly in the group meetings…"*

Additional formative experiences are built around immigration status and all it portends for international students: "*That's the most important parameter (shifts in seat, seats forward and continues to smile). If you are international student, and you don't have your permanent residency status defined here, I can't say 100% but 95% the only job that you can find is temporary in academia (bobbing head) so you can be postdoc, which would be academic job. You might can find an industry job in some of those local laboratories where your salary would be $20 per hour with PhD (expressing sarcasm)*" (P3-S2)

Students often comparatively analyzed their experiences in Canada with other countries of prior residence, building upon their interpretation of these comparisons: "*The Canadian system is not really, let me use the word is not really … erm … let me use the word it's not really so, erm, is not built for working students. In the German system it's really built for working students. So a lot of employers recruit students. So through the years I was beneficiary of that while studying and didn't have any … very rare in the Canadian system so, er, so working 20 hours a week, telling your employer that may not be so palatable.*" (P6-S3)

These comparative experiences might be personal or garnered from other people but they all are held as strong formative fundamentals: "*Maybe, maybe not. It also depends on which country we're studying. In Canada it's easier*" (P6-S3)

Defining the conceptual code of Career Thoughts

The conceptual category tagged 'Career thoughts" revolves around how international students' perceptions guide them in the transitioning of career projections and ideations. The conceptual category is made up of the codes 'University aiding students', 'thinking career trajectories', 'internationalizing the PhD experience' and 'feeling about PhD decision'.

University aiding students

When the efforts made by the university is either directly assisting students in their thoughts about career options, job availability or resource allocation, or students flag disjoints within the university's efforts, these all converge under the code 'University aiding students'. That particular code signifies the culmination of students' perception of the university's efforts:

"*Ah, I think as an international student … I feel that university has given me a lot of resources to get to know about these things, but at the same time hasn't like, there's no … outward effort. For example, this jobber, what do you say, career service, career fair, and everything, but it's very generic it's never for grad students. It's for everyone.*" (P4-S2)

Connected to this is the awareness of, and ease of access to, resources made available by the university for international students' assistance towards helping to facilitate their career goals. 'Awareness of University resources' conceptualizes the perceptions of students about the awareness of resources available in support of the triple helix, third mission, and specifically entrepreneurship and startups among international STEM PhD students: "*Unfortunately, non* (responding to questions about assistance by the university) *(Laughs) Zero. (Laughter) You have to take initiative to get to know about these things on your own. I wish it wasn't like this, but it is. (Pause).*" (P4-S2)

International STEM PhD student's knowledge about how, where, and when to access required career information is important for accessing relevant information about career thoughts, opportunities, and guidance. Equally important is the students' perception of how relevant the resources or information is, as seen in the code 'communicating, informing and assisting students by the university': "*And then the other thing is that I remember they used to have like, bring one company and they would tell all about the like, profile, blah, blah, blah. So I wish students could put inputs where Oh, like, if 100 students, write, like grad students, write the*

name of one company, they are inclined to invite them, over, just like an orientation session. And then grad students can interact…" (P4-S3)

Finally, under the code of 'university aiding students' is the code 'Concerning university and departmental impact on career thoughts' which reflects how students express their thoughts, concerns or ideas how the system is, or should be working: "*So, I think if there was a commitment also from the University to see that okay, one of the goals that we want to set for ourselves is that after one maximum 9 to 12 months, all our students that graduated must have a good paying job over x and x thousand dollars, and you find a way to track it. That will also push every single metric in that direction.*" (P8-S3)

Thinking career thoughts

Students' notions of what and how they may access preferred career options, knowledge about the options available, and the malleability in career prospects are relevant in 'thinking career trajectories': "*So I am guessing I cannot pinpoint an exact point but it's like if somebody might have asked me a question during my first year, I wouldn't have said yeah, I'm still into academy, I'm still into research but maybe in the second, third year now, most probably I'm up for mostly anything even into industrial jobs eve*" (P2-S2)

This gives appreciation to the concept of how, where, when and what drives international students' into finalizing what constitutes 'career preference' at the completion of their studies: "*So, I am at a point where I am er still undecided but still I have flexibility in the in journey*" (P2-S1)

Assessment of what descriptors are used when international STEM PhD students are 'describing nice jobs or better opportunities', and getting the definitions of such terms gives room for understanding their thoughts: "*Um … Like for me, I would estimate a good pay in terms*

of first I'm able to afford rent and live by myself. Like that is good salary, acceptable, decent, good salary. I'm able to stay by myself. I'm able to afford buying healthy food. I'm able to save 10 to 20% of whatever I have. I am able to eat out maybe at least once every week. And, um, let's say like some amount remains for miscellaneous." (FG)

Realizing the extent of similarity or differentiation imputed into the thoughts of international students enables an 'Internationalizing career trajectory thoughts' to situate the resulting opportunities or limitation perception about career thoughts: "*...don't know why that is, but I rarely or I even heard people from international background. There are motivated people there but still I guess they have er the risk reward ratio, they tend to put risk at a higher priority (smiles)*." (responding to thoughts about entrepreneurship and startups as career options) (P2-S3)

Putting these thoughts together with the awareness that these students consider variables beyond their descriptors for career preferences which indicates their innate motivation as they are constantly 'looking to learn and grow': "*So I'm somewhat in the middle. I'm inclined to get a PR, I am not so very hyper to get the Canadian citizenship, as of now. I want to, you know, explore all the avenues*." (P4-S2)

Internationalizing the PhD Experience

This code is a convergence of six of the initial codes formed. It connotes the variations, nuances, and/or divergence or convergence of the PhD experience for the international students which may or may not be in consonance with those of non-international students. As described by the code, 'Internationalizing the PhD Experience', interpretation of actions, submissions, (in)activity or reactions and responses are aspects of internationalization of students experiences". "*I think they, they just adjust, like they just adjust to what it is. I mean … I mean, they have to wait, they cannot say anything about it. So … yeah, I mean, for example … yeah,*

you have to learn to adapt there is no other way around it. … (pause) … I suppose like this. I mean, if you're international, you've already been through a lot. I mean, not in terms of torture or anything, just like you've moved to a new country and everything to a new language, new culture." (P4-S2).

Language issues, whether referring to command of the English language or even the formulation and use of expressions and manners of reaction, implications, insinuations and decoding of expressions, actions and activities, 'Recognizing language issues, internationalness and context' is of relevance in thinking career thought: "*Like for example for me it was really weird to learn that Canadians are actually apologizing for everything, not because they really think that they made a mistake just because that's Canadian thing (nodding vigorously and increased voice pitch). So and I didn't get that*" (P3-S2).

Contextual lived experiences of international STEM PhD students in the laboratories, departments, faculties, and even the university create implications that may or may not be significantly considerable by generic standards and values, creating expressions for 'Personalising internationalness in personal context': "*In terms of other things, if International Student is introvert that students will never be able to fight for his or her own rights. And of course, language is one of things but the other thing is that if you are an introvert you usually think low about yourself and if you're an introvert who came to foreign country you are already, so to say, 'damaged' because you are kicked out of your country. So that diminishes your self efficacy, self efficacy about everything. So you will feel not confident to fight for your rights and very often people will take advantage*" (P3-S3)

Graduate students often are married or in long-term relationship, and some have children. Where these relationships exist, they create an intersectionality for the specific student, 'Intersecting marriage, children and studies for international students' expresses some of the

connections in this network of the student's psyche: "*But erm, hi-erm … how to say that ... I wanted to be mother always but when I found out that I'm pregnant, I knew I knew we have to work hard on get to get our PR status. … I was scared that if I don't have PR, if I am not permanently a permanent resident here, my child will be born here and he will be Canadian, but if I get deported, what will happen with him like I was scared that I might lose my child because I knew that that's happening in US.*"(P3-S1)

Accessible information is vital at all stages of an international students' journey of socialization at the university and knowledge of how, when, and where this information is retrieved matters. By being international students, certain resources, though available, may not be accessible, or at least perceived not accessible to them as their context allows 'Internationalizing access to information'. "*And then the third probably is because in this university, we select our supervisor before coming here. We don't really know, we haven't interacted with them enough to know how they are. And so I feel some of us struggle with the work culture*" (P4-S2).

International STEM PhD students face similar challenges to other students, international or local, undergraduates or graduates, but the peculiarity of how they perceive their concerns through the lenses of their lived experiences is converged in 'Expressing most pertinent concern': "*... Yeah, I think if you are an international I think you're more supscep... Success... Susceptible to, to the, to some of the things … like problems with … I think you're more susceptible to low self esteem*" (P5-S2)

Feeling about PhD decision

Getting how students reflect on what they had envisaged prior to their PhD journey, their experiences, and perceptions during the course of their programmes so far, as well as how they

project this into their thoughts are all experiences that tailor their career trajectories post-PhD. Such reflections map the ways international students contemplate, internalize, and process their career thoughts. The summation of these six codes 'Feeling about PhD decision', 'Activities during PhD', 'Articulating PhD engagement expectations', 'Deciding why PhD' and 'Reflecting on why PhD' converge to express these feelings.

Expectations at point of entry into the PhD program for international STEM PhD students are determinants of the extent to which students may be inclined to stay on the predetermined career trajectories they had or to make shifts into other direction. To this end, understanding 'Feeling about PhD decision' elucidates these reflections: "*Um, …(pause)… yeah, so I I think one of, one of the expectations I had was that I would know more than what I actually know right now. … Which I think that nowadays now that I'm almost at the end, I think it's it's somad, It's some of those expectations were unrealistic*" (P5-S1)

As students experienced their PhD activities, whether extra-curricula or not, they build up a series of experiences that could determine their feelings as they continue their programme of study by emphasising these necessary 'activities during PhD': "*It takes a lot of time to figure that out. And at the same time you can't keep saying that, Oh, you're trying to figure out a problem. You have to also find ways to be productive to justify the funding.*" (P8-S2)

There is a certain way students articulate about their engagement expectations. Whether or not there were indeed expectations, or expectations were limited, the experiences of these students frame how they articulate it, subconsciously comparing it to their present and framing their future in reflecting on 'Articulating PhD engagement expectations'. "…*with a research of PhD to research again PhD from my own experience is that you're not like given this is what you must do every single day. You ask that okay, this is the area you have to address, find a way to address that with all that, maybe other similar obligations within your work*." (P8-S2)

Why did the students determine they needed to study for a STEM PhD as International students? Analysing such reflection situations forms the departure point of their career thoughts trajectory. How they journeyed to the point of 'Deciding why PhD' denotes a culmination of their experiences pre-PhD: "*Well, I decided what I will do for PhD even before I knew that I will have PhD*" (P3-S1)

Reflecting on the experiences leading to, while in, and transiting towards the future is the reason 'Reflecting on why PhD' helps understand the journey: "*So when I speak specifically about Canada, uhm, what I've noticed is that you don't have to be very highly educated to get a high paying job here. So, when you become a PhD you're automatically overqualified.*" (P4-S3)

Defining the conceptual code of Student Intersectionality

International STEM PhD students come into their programs with a single descriptor as 'international students' however, in reality they represent several different combinations of realities, experiences, and contexts. These variations consist of life's journeys with respect to gender, age, concerns, and situation in the countries of origin, marital situation, gender, financial circumstance, and more. Beyond these factors are also the specific experiences these individuals bring with them and are still living through during the course of their studies and when making career decisions. To represent these conceptual categories are the codes 'Reflecting on Covid-19 pandemic', 'Reflecting on self context' and 'Tapping student agency'. And understanding of how each of these are considered follows.

Defining the code of 'Reflecting on Covid-19 pandemic'

The COVID-19 pandemic created an unusual and unanticipated set of realities on the

world and compelled the rethinking and more reflective processing of expectations, experiences, circumstances, and situations because it exposed resiliencies, vulnerabilities and the complexities of what had become 'normal' hitherto. Situated amid all these were the international STEM PhD students and their unique experiences and dealings during that period which falls under this code and consists of 'Reflecting on COVID 19 pandemic' and 'Dealing during COVID'.

The advent of the pandemic meant a redesign of ways of life and living across board. This affected the learning experiences of international students and their gurgitations about the future in the code 'Reflecting on COVID 19 pandemic': "*... maybe, also maybe COVID changed a lot because maybe a lot of the information on the trajectory, like was ... hinged upon everyone being able to see each other being in school, interacting with the faculty, be able to manage complaints, not like waiting remotely for every single thing to be done.*" (P8-S2)

How students traversed the pandemic could be derived from their past experiences, immediate circumstances, and expectations for the future, all of which are converged into the code 'Dealing during COVID': "*But yeah, I think it is now like a fast process. I think it takes a little bit of time. Yeah. Or I don't know if that is my experience, but I've been here for ... three years and two of those years we were in, like er, isolated. So it makes everything more difficult. So yeah, maybe that situation has an impact on my opinion …*" (P7-S2)

Defining the code of Reflecting on self context

In this contextual category expressions and statements that suggest references to 'self', and communicates the international students' formative background, experiences and realities are converged. Under this code are converged the 'Reflecting on self context', 'Communicating intersectionalities', 'Contextual background', 'Contextualizing pre-PhD experiences' and

‘Personal value influencing actions’.

Such expressions about personality, familial background, preferences, appreciations, dreams, expectations, and similar thoughts, including other’s experiences relayed by participants give inkling to how they are ‘Reflecting on self context’: “*Yeah, I I, for example, I said that i'm curious and I don’t think that has ever been limited. Erm, yea I have had that freedom and (smiling) I think i've been lucky in that sense.*” (P1-S3)

Participants made expressions and statements, verbal or non-verbal, to the extent perceptible via an online meeting platform, which hinted at the existence of varied expectations and perspectives among international students. These are coded as ‘Communicating intersectionalities’. “*Erm, when I first came here I basically came to learn (laughs), and I was doing my master and I didn’t think about immigration for very much. I was just really open wherever, I wherever I get at the job. I will go as long as it's a good opportunity in terms of personal and professional aspects. Erm, but yeah, I think some people have other motivations, and probably immigration is one of them.*” (P1-S1)

The contextual background of international students in STEM PhD varies significantly and this feeds into perceptions and gurgitations about career trajectories. These are coded under ‘Contextual background’: “*So I did my undergrad and then I worked for like 3 months, and then I came here. So. I have always been a student. I do not know how the work culture is here. I don't even know how the work culture is back in my country.*” (P4-S2)

Specific experiences in the lives of participants are presented in manners suggesting they formed more indelible marks that others, thus are more relevant in students’ perceptions and decision making. These are converged in the code ‘Contextualizing pre-PhD experiences’: “*…like I have a broad experience I've worked in 14 different labs, and there were where you actually have a hard time being in the space, because there is so much negative energy*

accumulated that's not the case here, it's really respectful" (P3-S1)

Decisions about what to do and how to do it, and how to respond, or reaction to stimuli around us are always in response to our value systems, hence the code 'Personal value influencing actions': "*Like for example, I really strongly respect colleague who was here, both two of them was here before me ... they're above me, in my mind. I have not seen the structure of the lab but in my mind, they know better because they are here longer.*" (P3-S2)

Defining the code of 'Tapping student agency'.

Whether the outcome of decisions made by individuals are considered positive or negative, they are the deployment of the agency of the students in question. Even when students refuse to act, it still could be considered a non participatory use of one's agency. That is why this code is a convergence of five codes namely 'Tapping student agency', 'Confirming motivation', 'Denoting personal differences', 'Describing the use of personal agency' and 'Individualizing student outcomes'.

Students' agency in this context is not limited to what has been deployed, it also refers to references to perceptions of untapped agency, suggestions on how this could be done, expectations of what such could offer. It also extends to include 'offering' the university opportunities for 'Tapping student agency': "*And we work on that based on like, different backgrounds. We have like our group has mechanical engineers chemical engineers, petroleum engineers. So I think like with that amount of talent, i i think that like… but that's usually because we like legally we don't have that tool. Like to start that kind of or a company or a consulting firm. Because we are students. So yeah, I can like maybe I would say the supervisor to lead that. Yeah.*" (P7-S2)

Motivational factors for different aspects of their lived experiences comes for

international STEM PhD students in various ways, and are expressed in various forms. These expressions of what and how students express motivation are coded as 'Confirming motivation': "*And I guess that was just because I was so highly motivated to succeed. And I knew like as international students usually you know, that was when you left your country, there is no way back. You you burn bridges. And you know that either you succeed or you fail and you die. I mean metaphorically.*" (P3-S3)

Aside from exhibition of intersectionality of individual students, differences also exist in personality, attitudes, and response to stimuli as indicated in the code 'Denoting personal differences': "*I always wanted to become a part of erm … I never wanted to become a part of academia to be very honest, I don't enjoy teaching at all. But I enjoy doing research.*" (P4-S1)

Utilizing agency is separated from instances of noting, suggesting and ideating about this. Reference is made in code 'Describing the use of personal agency' to instances of agency deployment by students: "*Er, I think the culture kind of … kind of make me more independent, because I don't have many people to ask help for but otherwise, I have I have to take more responsibility.*" (P6-S2).

Knowing that the situation of individuals in the same laboratory and under the same circumstances does not predict a singularity of outcomes thereby denoting the need for 'Individualizing student outcomes'. "*But I really think like the way that you… have opportunities in the future, it depends mostly on you. Like every lab it always offered something to you, so it's always up to students, how they approach those opportunities and how they take advantage of that, er, thing, that environment and do something*" (P7-S1)

Defining conceptual code 'Supervisor has impact on career path'

Students in the PhD programs are mainly under the tutelage of specific supervisors who

socialize them into the academia and industry. Specifically, international students entry into the country and educational ambitions are directly connected to the behest of their supervisors. How these students see, pursue, and accomplish their career goals is expected to be impacted by their research laboratory and supervisor's influences. This conceptual code consists of two codes named 'Supervisor has impact on career path' and 'Laboratory culture'.

Defining the code 'Supervisor has impact on career path'

International students in STEM PhD express expectations about their participation in their research laboratories of choice. They express how the supervisor is either expected or not expected to guide them towards their preferred career choices. This code consists of five others namely, 'Supervisor has impact on career path', 'Situating PI's past experiences', 'Role modelling own supervisor', 'PI creating opportunity and environment' and 'Affirming PI's research influence'.

Statements that are connected to the impact supervisors have, directly or indirectly, positive or negative, are coined under this code to indicate the encouragement or disenfranchisement caused, and called 'Supervisor has impact on career path': "… (in response to how to secure opportunities) *I assumed that you didn't have many years of experience, because if you did, you would know how much it matters to have professor who will connect you. That is actually 95% of everything so you might do(n't) need it.*" (FG)

To give insight into how the supervisor develop their clout and laboratory culture the experiences of said supervisors offer some perspective as it enables us in 'Situating PI's past experiences' and its impact in their current role and activities: "… *it matters a lot that we… so we have also co-PI, co-supervisor who was in, still is in industry, he's like a half-half. So, that pretty much help us a lot to decide what do we want to choose for our further career.*" (P3-S2)

Dependency of international STEM PhD students on their supervisor is a function of the extent to which they can see the "role model" in these PIs. How well they find themselves relying on the PIs guidance is indicated by the strength of confidence in role-modelling the supervisor. These thoughts are condensed under the code 'Role modelling own supervisor'. "*She's providing you with the knowledge, (slurring words slightly as a continuous flow, while bobbing head in constant accent to own statements) she knows how to explain. She leads you properly so she doesn't lead you to the dead end, which is in our field, very important.*" (P3-S2)

How a supervisor builds the culture within the laboratory can either frustrate or encourage students. The engagement patterns, guidance and decisions made under the tutelage of the supervisor are ways by which students perceive their 'PI creating opportunity and environment': "*I would say I had more opportunities than other international students but it also depends on the PI and the lab culture.*" (P6-S2)

The supervisor is the main lead in every research or engagement done in each laboratory. Irrespective of the relative independence, students activities are influenced by the interests of the PI. This code named 'Affirming PI's research influence' represent enunciations of such: "*So the er, the … interactions that we have had, the macerations that we been doing, the demonstrations that we've been doing, are mostly organised by our supervisor. So that lab… point is basically set by our supervisor*." (P2-S1)

Defining the code 'Laboratory culture'

International STEM PhD students mostly arrive in the laboratory as new immigrants into the country and derive all their initial and ongoing socialization into the laboratory, the university, and the local community from how they experience the established norms within their laboratories. These norms are established by their supervisors and preserved by other

members of the laboratory. The code ‘Laboratory culture’ consists of itself and others named ‘Communicating in lab’, ‘Defining Mentorship’, ‘Laboratory Community’, ‘Laboratory leadership’, ‘Laboratory structure’ and ‘Reflecting about laboratory’.

Overall, the perceptible culture within the laboratory, positive or negative, consolidates the values, attributes and expectation of these students. Coded ‘Laboratory culture’, it reflects the extend of faith students have in the workings of their laboratory: “*(Laughs) We're always joking we call like my lab a circus (laughter) because recently my PI he just recruited too many people and er with without the experience, experience in our lab because our lab we have a very specific skill set that people just come to learn.*” (P6-S1)

An important component of the laboratory culture is the efficiency of communication within the laboratory, among the members, and the PI, and the issues of discussion. Communication also concerns the exclusivity or openness of ‘Communicating in lab’: “*Yeah, I think the culture of having meetings every week also helped because we … will … we will pretty much seat at the hole every week. Erm … erm, so that kind of helps you get to know each other. Not every not every science, science lab in the Department would do that kind of thing like meet every week to talk about someone's project.*” (P5-S1)

The value of the structure, leadership, and established communications within the laboratory work towards guiding the students towards achieving success. This is possible mentoring. Students ‘Defining Mentorship’ gives a view of their access to, and appreciation of the cultural systems in their laboratory: “*So even if I think it goes beyond the thesis, a mentor will not restrict Himself to four years of your thesis that is, erm, my definition. Yeah.*” (P4-S3)

Research laboratories are a convergence zone of diverse peoples from diverse cultural backgrounds, different immigration, experiential, work, and several other diverse renderings to form a ‘Laboratory Community’: “*And we have coffee, we work together inside the lab, and we*

also spend time outside the lab and if I'm having any problem I have a postdoc who is the first point of contact even before my professor I asked him for advice about the content they talked about, he's very supportive environ - environment." (P4-S1)

The code 'Laboratory leadership' brings to bear the positions of the postdocs, the hierarchy within the laboratory, laboratory management, and the laboratory work culture. These factors determine the flow of authority within the laboratory: "*We are really all equal. Even though some of us are more extrovert, some of them are more introvert, but we are equal in things like there is no one leader and I I think that that is not necessarily good thing*." (P4-S3)

'Laboratory structure' code captures the roles and functions within the laboratories and highlights laboratory sizes and composition, multilevel mix of postdocs, research assistants, PhD, masters and undergraduate students: "*And in our lab, we have within the lab, we have four different research groups. So we are very diverse in the er, in this like the way that we work and the topics that we are working on. So that is very nice. And you get to talk and you get to learn a lot of things outside your er theses and your work.*" (P7-S1)

Contemplating the work culture, and practises, work organization and design, gaps within the scope of work within the laboratory and the match between this and student's past are captured under the code 'Reflecting about laboratory': "*And um … if the country you're coming from, you know, even if you don't have that culture of collaboration and or … you come for a different culture and then you get inserted into North America's research culture... If there's a lot of mismatch between those two, you're gonna have issues*" (P5-S1)

The above section served to indicate the conceptual categories, sub-categories and focused codes. Examples have been given to indicate these and enable the flow of thoughts that went into the coding process. The next section will detail the connections of the categories and give insight into the theories formed.

Chapter 4 - FINDINGS

Introduction

This study is directed at hearing from international STEM PhD students their perceptions on how the research laboratory culture impacts on their postgraduation career decisions. It sought primarily to establish that the perspective received are from the international voices, and to identify what forms their perceptions and the role these perceptions play in their career choice decision. The study delves into the layers of international students' socialization processes in their research group and understanding the lead scientist's (supervisor or PI) and any other factors that impact on their future career trajectory. The design of the study was optimized to answer the main question of: 'How does the research laboratory culture impact on international STEM PhD students' self-reported projected career trajectories as they proceed in their doctorate program?'. The study was designed to further answer possibly questions among other possibilities: a) How do laboratory group entrepreneurial cultures vary within the university's STEM departments? b) What variables do these international students adduce these variations to? c) How have these established laboratory entrepreneurial cultures as perceived by the students impacted students' career identity, socialization and evolution? d) How do the students project these perceptions will impact their career decisions about their post-doc engagement? e) How strongly do they perceive their lead scientist's engagement culture on their personal planned trajectories? (f) What addition intersectional variables do they identify as most strongly significant in their decisions as international students, if any?

The previous chapter expiated the detailed study methodology and presented the four conceptual categories namely 'experience', 'career thoughts', 'student intersectionality' and 'supervisor impact'. The coding process was articulated and the component codes forming the sub-categories were detailed. This chapter, however, provides an explanatory discussion of these conceptual categories. The discussion in this chapter is guided by the different theoretical

perspectives as presented in the literature review. This chapter will explain the transition from the subcategories to conceptual categories and their properties. A summary is provided at the end of each conceptual category. The chapter starts with the reintroduction of the study participants, the conceptual categories, and detailed explanations.

Response overview

In all, eight international STEM PhD students participated in the study from various departments within the STEM and Applied Sciences at the University of Alberta. The participants had various levels of graduate education prior to their PhD, the least being 2 years and the most was 4 years. Two of the participants had prior studies outside their home country prior to their PhD, while only two had no prior studies in English language before the commencement of their current studies. The remaining six participants had English language exposure ranging from 2-6 years, out of which three had exactly two years of prior English education, and a participant identified with English as a first language. Two respondents originally speak Spanish, one speaks Portuguese, one Malayalam, one Mandarin, one Hindi, one Serbian and the last one English. They represented one African, three South Americans, one European, and three Asians.

One participant had transitioned through masters' program to PhD under the same supervisor, but all others had first contact with their supervisor online via websites with one participant having been contacted by the supervisor directly. Among the participants interviewed, all arrived in Canada within 3 months to the commencement of their studies, the exception being the participant who had completed the masters under their supervisor. Five of the respondents are from the faculty of engineering while the other three are from the applied sciences. Five participants identified as females while the others three were males. Two participants were married and resident in Canada with their spouses. One of the married

participants had a child aged 0-2years. The diversity presented by the participants' identities make the outcome of this study more robust. It gives vent to the voices of international students from different parts of the world and their different lived experiences.

Experience

This conceptual category represents the participants various experiences in Canada. It merges their Canadian non-academic or community experiences, social interactions, and fitting into the laboratory with their experiences earned in all engagement with industry, academia, and government respectively or in collaborations. The subcategories under this conceptual category are 'Working the triple helix' and 'Adjusting to the Canadian environment'. A detailed explanation on these sub-categories follows.

Working the Triple Helix

This is a subcategory formed as an umbrella for codes including itself that express how the participants experienced work they had done with university, industry, and government. Students work with these arms of the helix at the prompting of the six categories that make up this subcategory are explained below.

Engaging with academia

This property expresses participants ideas about engagement in academia, their opinions about interest in academia based on prior experiences and future expectations. The data shows what participants considered engagement with academia with the specific kind of activities they had either actually done or anticipate doing if they work with the academia. Many participants consider the work in academia to be about research and teaching. "*So for me, academic work*

will be er, about er research job. It can be what? In a university, it might involve guiding students, it might involve teaching, so that is in my sense, an academic job" (P2-S2).

Certain students have directly experienced the engagement with academia. And their experience has seeded them with the desire to further a career in that direction post graduation. This presents the supposition that participants' opinions about academic work is connected to the exposure they receive while under the leadership of their supervisors. "*But we are … I'm mostly related to the academia and teaching which is my primary goal. I do want to proceed as a professor.*" (P3-S1) "*I have had the opportunity to teach I'm actually very curious about academia and teaching positions*." (P1-S1)

Many participants, including those who had not directly expressed exposure to the academia all expressed what academia means for them. Some of their expressions in these data seemed laden with undertones suggesting lack of interest, and even possible detest for a certain perception of possible monotony or even publishing papers as expected in academia, by their opinion. "*Academics usually focus more on science than publishing papers, yeah publishing papers. That makes a big difference*." (P4-S2).

In contrast, for some participants, the academia offered unique and highly valued opportunities they looked forward to, including adding value to society. "*What academia means for me is basically a place where you … create or develop knowledge and knowledge that can be used for practical reasons, used to understand er the world, (looking up thoughtfully) er knowledge that can be used to create promises*" (P1-S3)

"*I think that academic science promotes collaboration between different groups and different people and sharing the knowledge is pretty much required because if you keep your knowledge in a bubble, and you're not telling it to anyone, you are running into the problem of missing important parts that might even improve your research studies but because you're not sharing you don't know like 'Don't Ask Don't Tell' thing"* (P3-S2)

Drawing on different suppositions the general perception is that at least majority of PhD students' thoughts are directly inclined towards post graduation work in the academia. This stereotype is debunked by some participants who expressed complete lack of interest in academia. "*I always wanted to become a part of erm … I never wanted to become a part of academia to be very honest, I don't enjoy teaching at all.*" (P4-S1)

Engaging with government

The data under this code denotes participants ideas, opinions and thoughts about experience working with government. Some also describe how they got involved or connected with these engagements and projects. The kind of work done with government suggests participation in what might be called government advisory commissions or 'think tanks' designed to give policy guidance. "*I think most of the engagement in quote, has been more policy, public sector related engagement on a policy level, which is government.*" (P8-S1).

The extent of exposure to government engagement varied such that some participants could only draw on the experiences of others, such as friends outside of their own laboratory groups to determine for expressions about government engagement. Such students relied on the opinions and experiences conveyed by others to determine the experience of working with government. "*Erm … I, I would think, er, my friend, they sound… some of some of them worked with government*." (P6-S1)

Certain participants sounded off with a tinge of pride about the high extent of their government engagement within their research groups insinuating copious collaborations with government. "*But governmental organizations involvement, I would say a lot. They have not, I do not have a number for it because it is a lot*." (P2-S2). While this was contrasted by expressions of surprise, even shock, at the possibility of government engagement by others. This group could not conceive of how engagement with government could be formulated because

they had neither experienced it nor been given any indicators suggesting the existence of such collaborations. The expressions however indicated a lack of direct contact or experience working with employees of the government.

Understanding the participants connection of engagement with direct engagement with representatives of government suggest the source of detachment for this mode of engagement. "*I do not know about the Government to be very honest, but I do know that my project in particular is TN* (an industrial jargon/acronym I'm uncertain of) *project, which was given by the government of Alberta to University of Alberta. When you go down or around the chart, I become a part of this because I got something from my principal investigator*." (P4-S1).

For those who seemed not to experience this disengagement while working with government, the thoughts of possible career with government remains an active option. "*I could work for the government I can work for both provincial and federal governments I can apply for, if I want it*." (P5-S2).

Within the expressions of these international students experiences are the limitations imposed by their immigration status in Canada. Enmeshed within the international students' study permit is the exclusion from jobs and careers with the government; a fact well nuance by a number of participants. This precludes the possibility of such career options for those students who are aware they will not have qualified for Permanent Residency 'PR' before they seek for post graduation jobs. "*But I applied for some jobs within the provincial government here and got to interviews. I did two interviews and, er, that was only possible because I was a PR in Canada. Otherwise, er the system would just exclude me from that process before*." (P5-S2). "*Well, um, I think if you want to work for the government, well it doesn't make sense, they're gonna give priority to erm, people that are not international students they will be priorities. Um, for citizens*

or like Canadian residents, I think, I think that would be probably the main part why you don't go there." (P1-S3).

Engaging with industry

Many participants' opportunities for industry engagement came mostly as part of their programmes, where applicable. The supervisors design of the Research being done in the laboratory, the culture of engagement established within the laboratory forms the bases of these engagements and they occur in different formats as expressed by some participants. "*So where there were a lot of industrial collaborations. So this would involve demonstration to industrial people in our labs as well as working in sites at industrial facilities.*" (P2-S2). "*Most of the projects in our lab have been related to industrial projects. So. It has been nice*." (P1-S1).

For some participants, the pre-knowledge of what and how the research laboratory's culture around industry engagement constituted a decision variable at the point of application to the PhD programme. "*I still … joining this lab because this lab is the only kind of interesting lab in the whole department doing something like related to industry to kind of more creative industry*." (P6-S2).

Various experiences garnered through industry engagement and collaborations has produced interest for career in industry for some participants. "*I would say … I am actually kind of been influenced by the interesting collaborations and research work that we have specifically done for industry, that might have played a role*." (P2-S1). Beyond the engagement and collaborations some students are swayed towards industry careers in a bid to replicate their experiences while engaging with industry.

Experiences from their engagement suggest to them their fit for similar functions and positions in industry. "*I think that will also open the door to not something else that you could be curious about, not just what you have in mind, but it can open the possibilities*." (P1-S2).

Primary source of attraction for those who had worked in industry in the course of their programme and are willing to explore possible career opportunities in industry is tied to their collaboration experiences. How well the dynamics worked when they worked alongside industry representatives determines how they perceive the outcomes if they choose careers in industry post graduation. "*Because you're working with a company, I mean, at some point, at some point you feel like you're part time working there too. Like you meet with people, you know how they talk, you, you give presentations to them, you're selling them something.*" (P4-S2). This expression reifies the disinterest expressed for government engagement for participants who were working on government project but noted no interest in seeking career opportunities in government owing to lack of interaction with government representatives.

Some participants who expressed lack of experience in industry engagement were well opinionated about the parameters and outcome of such engagement. They relied on information they had got directly or indirectly from the experiences of other students to draw conclusions. These conclusions and observations are strongly held by these individuals because of their lack of any experience to erase such perceptions. "*Okay, maybe for now I've really not decided to be that much exposed to industry, because er, getting exposed to industry, you're wondering, besides maybe trying to ensure that what you're doing in relaying data and every single thing of what the industry desires*" (P8-S1), insinuating a lack of research independence in industry. "*So in terms of industry based science, one thing that I don't think I would like and I don't think I would fit well is that whenever you do science in industrial world, most of the data that you generate are not publishable because most often they are protected by patent and you cannot share data*" (P3-S2) also insinuating a high level of research control by industry.

Opinions varied about expectations on the value and impact of the PhD degree on the pursuit of an industry-based career upon completion of their PhD programmes. Expectations ranged from the constriction created by the highly specialized connotation of the programme and resulting perception of expertise to include the availability of job opportunities for such high skill sets. "*It's specifically for Canada. Having a PhD makes you over qual…, qualified for a lot of job jobs because people are not looking specifically for, for PhDs.*" (P4-S3). "*A student of with a PHD degree can be overqualified.*" (P1-S1). Anticipating the possibility of being castigated by overqualification for jobs is considered a plus for internationals who would otherwise have been acutely underemployed in the Canadian work environment. "*In addition, so now on top of that, you might be overqualified (chuckling), which is kind of weird (chuckles). But at the same I don't know, I think at the same time the fact that you are an international student and will hold a PhD degree might actually work on your benefit if you know how to use it.*" (P5-S2)

Some opinions were expressed about expectations some individuals nurse about salary in industry compared with academia. "*But it is really a myth that industry is so much better paid than academia. That's just not true. That's not true*" (P3-FG). Opinions regarding how industry engagement funding is structured and the implications on where attention of such scientific engagements are focused was raised by some participants who opined industry's sole focus is on profiteering. "*So what I noticed is mostly commercial er research project projects are usually funded by company and so they focus on application rather than science*" (P4-S2).

Such opinions seem have made some lasting impressions on some participants. "*And for industry … For for industry er, sometimes I feel like they focus too much about money and er they can, they could make they can make things things to work better, but they just didn't and we heard some like scandals, er, industry tried to scam people with very nice projects, but they actually don't exist.*" (P6-S1).

Comparing collaborations within the Helix

Data collected during discussions had many participants comparing their experiences, observations and assumptions about experiences garnered about engagement between academia (university), industry and government. Many statements made mostly compared engagements between academia and industry, academia, and government, with few expressions from participants about government engagement. "*I never collaborated with government, so I cannot comment on that. Hmm…er, collaboration with industry versus academia, there is a difference (nodding).*" (P3-S1). Some participants did not directly express a comparison between the various members of the helix but implied it in their expressions about their engagement experiences. "*Nobody will like … it's actually encouraged to share what you discovered. And that's what I like (head bobbing) because I think that academic science promotes collaboration between different groups and different people and sharing the knowledge is pretty much required*" (P3-S2).

When asked to make comparisons between the sectors based on their experiences, participants expressed various preferences in the data collected. Some of the participants focus on how the knowledge created during collaborations are permitted to be shared rather than for general purposes. "*So when industrial job where I am working, and industrial and industrial and Academy they would say it's more like even in an industry, kind of like you might have to … the amount of knowledge you're transferring to a person can be limited*" (P2-S2).

Others evaluated their experiences from the perspective of the end products for each sector rather than actual collaborations. "*So what I noticed is mostly commercial er research project projects are usually funded by company and so they focus on application rather than*

science. Academics usually focus more on science than publishing papers, yeah publishing papers. That makes a big difference. Erm industries don't really care for that" (P4-S2).

Thinking about the prospects for post graduation career however, certain participants expressed possibilities across all sectors to the extent that opportunities present. Even with respect to possibilities of obtaining jobs with government, the decisions of government and consequent pronouncements about the employment of international student graduates will be the determinant rather than a lack of desire for government work in the opinion of some participants. "*…we see a lot of people graduate and then quickly gets into industry. It could, some of them also go into government. It tends to what the Canadian government indirectly desires, you see a lot of them shaping policy*" (P8-S1)

Feelings about entrepreneurship

As the research progressed, the dearth of knowledge and access to entrepreneurial training, resources and opportunities became apparent. Whether entrepreneurship was defined as startups, innovation, commercialization, or any other form, made no obvious difference in the extent of exposure most participants had experienced during their PhD study. Participants responses to enquiries about entrepreneurial engagement in their respective laboratories highlighted differences of opinion about the topic that indicated some participants had no prior access to entrepreneurial knowledge in their studies.

Many reported they had no prior exposure to any ideas or possibilities of entrepreneurship within the scope of their laboratory work. "*So there are no previous people who have, you know, even worked on startup. So, there is no precedent there as well (gestures as though bringing things in) to, for students to join in even though they might have worked*

previously, (sniffs) but still has, the group in its culture doesn't have, I will say yea, starting business ventures, especially" (P2-S3 – South Asian, Engineering student).

"*I don't think there is ... I think that in fact that … what that actually means in erm, some of the possibilities to to become an entrepreneur is I don't think that has never been a topic of discussion in my lab. I don't think anyone has ever brought this up. Yeah*" (P5-S2 – South American, male, married).

Although some participants indicate a desire for exposure to entrepreneurship training, they feel a sense of need to keep such aspirations to themselves due to their perception of lack of interest or possibility of support by the supervisor or the university system. "*We haven't been equipped for that. Like this. this is something that I've been thinking like a long time ago, like, this is like a personal thing. But I don't feel we have been equipped with that, like at the university or our supervisor or No, I don't I don't think so*." (P7-S2 – South American, female, married).

"*Erm, there's none (laughing and shrugging). I do not see that in either of the groups. I wish there were, because i'm very interested in entrepreneurship, a lot more.*" (P4-S1 – South-East Asian, female, single).

Noteworthy is the fact that among those participants who had engagements with industry they could not see any inclination towards entrepreneurship in those collaboration experiences. "*(Pause) … Hmm … I wouldn't say that. It is … Yeah, because it's not like we get those insights or to be an entrepreneur. We just … participate of projects and we keep working on things that are of interest in in the industry, the particular industry here or in academia as well.*" (P7-S1 - South American, female, married).

Suggesting explanations about why the focus on entrepreneurship is low in the STEM PhD programs, participants express the complications of combining research work with

entrepreneurship. "*Well, no, maybe not my lab because of course, you can't, you can't be doing entrepreneurship while you're doing the kind of research work we do because your whole mind is featured on that…*" (P8-S2 – West-African, completed MSc. in Europe). Other explanations suggest the implied conflict in expecting academic supervisors to direct their students towards entrepreneurship. "*Oh, that's a very hard one because for them to be Professor they're probably not interested in doing entrepreneurship (smiles)*" (P8-S2).

Some more thoughts implied there might be no interest towards entrepreneurship among their research group members within their laboratory group members. "(Responding to how entrepreneurial the laboratory is) *No, no, no, would be great, but you know, not that I know. We are all pretty much similar all basic science people.*" (P3-S1 – Eastern European, female, married, mother).

However, for those who express prior exposure to entrepreneurship and startups, they indicate their engagements was in their home country before the commencement of their PhD studies. "*Entrepreneurship, very few … when we do entrepreneurship (its) more like interfacing on a personal level with, maybe my home country but within the context of what is existent right now within what I do in my PhD*." (P1-S1 – South American, female).

The basic notion expressed indicates the research group's culture and its impact on the growth of entrepreneurship among group members. The experiences within the groups do not prioritize business idea generation but sometimes enables collaborations with startups. "*So I have seen some collaborations with startup, but per se there isn't like a generation of er, (nodding), er, business ideas within the group itself. So I don't think it is culturally there within the group*" (P2-S3 – South Asian, male).

As the interviews progressed the realization of multiple implied connotations for such entrepreneurship arose. This observation warranted the need to hear individual students'

interpretation of the term ‘entrepreneurship’, and it also led to the need to understand what they each meant when they used the words ‘commercialization’ and ‘startups’. Asking these questions brought a few ideas to boot. Asking participants to express their own interpretation of entrepreneurship had many drawing on their previous experiences with entrepreneurship, both experienced directly or learned from others’ experiences, or their interface or non-interaction with the subject. “*Isn't that business? I mean, I wouldn't be… I don't see the difference. I can see the commercialization as a business. That's why I'm saying I don't have business dream. Because for me, that's the same. If some something is commercialized, that's a business. I’m not for business. I am scientist … clear as it is.*” (P3-S3, pre-PhD studies in Eastern Europe and United State).

“*Hmm, hmm, erm, like its, erm a startup is … that will be like a company right? Well I think for you to create a company you need to have someone that is open to create something new*” (P1-S3 – completed MSc under PhD supervisor).

“*Er, very little (laughter). Erm … (pause) … I’d say I even have difficulty trying to define what entrepreneurship is. I don't think there is ... I think that in fact that … what that actually means in erm, some of the possibilities to to become an entrepreneur is I don't think that has never been a topic of discussion in my lab. I don't think anyone has ever brought this up. Yeah*” (P5-S2 – Applied sciences, male, married).

“*Oh. Like finding an idea that was worth pursuing and just executing it and driving value for, of course, as an if you’re a sole entrepreneur for yourself, but if there’re people funding you, who are partnering with you, for the collective group of the individuals funding you and your product should be able to make a difference in people's lives without creating like, a negative impact*” (P8-S2 – Completed masters education in Europe with exposure to entrepreneurship, engineering student).

Delving further to unbundle participants thoughts about entrepreneurship, they were questioned about their likelihood to participate in entrepreneurship in any form and participants responses varied from palpable interest to total lack of interest, proffering a variety of thoughts about why they are interested or not. "*I would say we're not interested in that at all. I think we oh, we, our minds, that (is) kind of fixed not thinking we are actually able to set up, to have a company we are always thinking about yeah, just get a job and that's get an easier life and that's it*." (P6-S3 – East Asian, applied sciences).

"*I think it's, it's, I mean, I don't think I personally, will start a startup but I can definitely join someone that is willing to see some new. I I feel creating a company, there's a lot of responsibility*." (P1-S3 – South American, female).

"*For this, I'm not sure because I don't think I have the ability to start a company myself.*" (P6-S2 – East Asian, female).

"*I mean I personally, because i'm interested in entrepreneurship, and at the end of the road I see myself making a company of my own (raises both palms upwards)*" (P4-S1 – South east Asian, no prior work experience, female).

When asked why these participants might not consider entrepreneurship at their stages of study and in the post graduation career thoughts, their comments indicated a variety of reasons that included the impact on their studies, finding appropriate resources, and limited information. "*It's an intensive process*" (P2-S3 – South Asian, male).

"*I I feel creating a company, there's a lot of responsibility.*" (P1-S3 – South American. female).

"… (Supervisor's) *priority is that this individual that is working, this person working in my lab must solve the problem that is given to him and I'll give him the support for that. 'My first priority is not to give support for entrepreneurship'. Because if you wanted that you probably*

would not have come to do a PhD or a masters on a research level." (P8-S2 – West African, completed masters in Europe, male).

"*It's an intensive process. A lot of … Yeah, it's like from a technology perspective as well as … er … the even getting a patent doesn't mean it's going to be, you know, the final risks over yet*" (P2-S3 – South Asian, male).

Getting further insight into how participants viewed entrepreneurship specifically with their lenses as students of engineering and the applied sciences highlighted additional thoughts about why they figured they could be involved or not. Certain participants saw getting entrepreneurial exposure as an opportunity to garner alternative knowledge for post graduation career thoughts. "*Because if you know that, doing a research is not just going to be targeted towards to getting a job or working in academia. You may also use that as a like another option to get into afterlife or corporate world for instance, or even thinking about commercializing your product or your or your or your research work to a good extent maybe*." (P8-S2 – West African, completed masters in Europe). Someone else saw it as useful knowledge to have. "*But it could have been a practice to … talk about it, right? Like yeah, having patents is good, having or being part of a startup within the group is good. It's a good exposure, it's a good learning field. Maybe you will see that being successful in the future as well.*" (P3-S2 – Eastern European, female, applied sciences).

Information about entrepreneurship was accessed from 'random' off-campus sources in the experience of another participant who was self certified as unable to become entrepreneurial at first interview session. "*For this, I'm not sure because I don't think I have the ability to start a company myself. But I do see some people there. I think there's organization just help Edmonton students who start their own business I see them distributed some kind of the coffee coasters and trying to talk to people about that. I don't think we're exposed to that enough. But also on*

LinkedIn there are some random people messaging me about hey, like, 'Do you need help for startup company entrepreneurship?' That's the only thing I got contact to." (P6-S2- East Asian, Applied Sciences).

A number of participants had initially reported total lack of interest in entrepreneurship, however same participants declared possible interest in entrepreneurship if they had access to more information and had assistance to cover issues they considered were their inadequacies. "*Hmm, (Pauses and looks thoughtful) I think it's, it's, I mean, I don't think I personally will start a startup but I can definitely join someone that is willing to see something new.*" (P1-S3 – South American, female, Engineering).

Responses from participants indicated a perception of an 'internationalization' of the barriers to entrepreneurship for students. Internationalization means these are barriers that are exclusive to international students, although they may not be general for all international students in the STEM PhD. Some of the identified challenges mentioned by participants when asked about such peculiarities produced a few interesting and noteworthy thoughts.

P2 – South Asian, male, engineer, prior exposure to startups from home country: "*I'm guessing it's a multifactorial problem. So might be a couple of factors that I found but there are I'm guessing a lot of other factors. I'm pretty sure that there is a barrier there … There is a barr… otherwise I would have known. At least within our group, study group, people we study toget… that is mostly International.*" (P2-S3). "*It is stressful so some people can't cope with it. Imagine that in er in an international here, I'm guessing … there are better opportunities and better … but they might think it is okay to live a comfortable life rather than a stressful entrepreneurial* (life)" (P2-S3). "*But even with a lot of support here, I don't see much motivation from international students.*" (P2-S3). "*Most of the conversation is about … getting er … getting the degree completed, either getting PR or citizenship and then think about… so that it is easier.*

And … So, at the moment, for a student, with international background, I'm guessing that is it." (P2-S3).

P4 – South-East Asian, female, engineer, no work experience prior to PhD programme: "*So that, the second most important thing is network, I feel, and same reason I'm International. I don't know how things work here. So, a good network and… then is a good foundation, like founding member team, like a very small team.*" (P4-S2) "*I mean I personally, because i'm interested in entrepreneurship, and at the end of the road I see myself making a company of my own (raises both palms upwards). If they were inclined of course (raising both palms together upwards and smiling) … erm… I would work at least 2 times harder or 3 times harder, because I'm seeing an end goal and I'm seeing them pushing me towards it*" (P4-S1).

P6 - East Asian, female, applied sciences, explains that fulfilling immigration requirements is usually higher priority for international students than considering entrepreneurial pursuits, and for that they need a job. "*I would … they … I think most of international students they're still thinking about just get a job and have a stable life and maybe emigrate to Canada or something.*" (P6-S2)

P8 – West African, male, engineer, had exposure to entrepreneurship while studying for masters in Europe where he says it was easier for international students to become entrepreneurial because the basic structures were in place by the university, industry and government. "*Those, and also when it comes to intellectual property, because when you're working in research, your intellectual property, the intellectual property of your work is on the university. Right? So for you to be able to pursue it further you probably have to leave* (school and PhD study) *and go into the realm of entrepreneurship*" (P8-S3)

The issue most mentioned as a barrier to international STEM PhD students' participation in entrepreneurship type career choices was finance. Inability to know and how to access the

finances for capital for interested international students was reified by several participants. "*Er, I think for that first where I need the money to start with and I need to kind of persuade the investors and I don't know anyone who are investing (laughs).*" (P6-S2 – East Asian, female, applied sciences).

"*It might not be let's say financially er, … er, secure. But I am guessing there are like lack of financial support that they are afraid of and the risk associated with it and they might feel that … If you fail with that, I guess the financial burden maybe too much*" (P2-S3 – South Asian, male, engineer)

"*And then I think just funding, like, I don't have backing I, my parents cannot support me, they cannot be my angel Investors or whatever. I have to look for people.*" (P4-S2 – South East Asian, female, engineer).

As participants had been generous in their information concerning access to information, lack of knowledge and finances to pursue entrepreneurship as international STEM PhD students, it seemed pertinent to hear their suggestions on how to change this status quo. Some participants expressed their perceptions on how the entrepreneurial agenda can be better embedded into the STEM and Applied Sciences graduate students' socialization.

P2- Suggests more discussion about entrepreneurship in Canada within research laboratory groups. "*For me the choice of choice in the research group, it's not I am not even worried that you don't have enough patents. But it could have been a practice to … talk about it, right? Like yeah, having patents is good, having or being part of a startup within the group is good. It's a good exposure, it's a good learning field. Maybe you will see that being successful in the future as well.*"

P3 who had expressed possibility of visiting entrepreneurship with collaboration after initially indicating a lack of interest had no suggested but responded to the thought of

establishing mandatory entrepreneurship programme at the University of Alberta. "*I think that would be fantastic.*"

P4, a female engineering PhD who identified as not having worked between masters and PhD but with dreams of eventually becoming an entrepreneur wanted the university to draw from its pool of successful alumni business owners. "*Maybe one lecture on how like some entrepreneur who, who graduated from here and built his own system, someone who's in a great post, and he's continued to do research, someone who's maybe a consultant in a really big company who graduate graduated from here. I think that makes more sense to me. But what do I know? (Laughs).*"

P4 further suggests a better targeting towards encouraging entrepreneurship in graduate students by recognizing that some graduate students may be entrepreneurially intentioned when school is organizing programs for graduate students. "*they do organize stuff but it's typically for undergrad students. They don't have problem statements (shaking head) they do not like … I I see a symposium and its like, its boring (smiling), you know, it's very academic but grad students are not … (eyes get bigger and smile continues) … Every grad school is not an academic…person and they don't organize stuff like … they organized BDR in my department but they do not organize competitions or (eyes widen and both hands wave) entrepreneurship!*" (P4-S1)

"*First let's imagine like random cases, taking a cla class, even though it's optional, like business plan development and business model development, lean process development for businesses, even if they're optional, or credit based within maybe another faculty business group, but the option is not created to be pursued.*" (P8-S3)

"*Maybe University of Alberta maybe there could be more support for let me say Entrepreneurial boot camps and everything, startup engagements, and that, especially from the masters level, that could be done, even if it's done is not really public. Or publicized*" (P8-S2)

"*But I mean everyone has it, but I think International students have some hesitancy regarding that ... so that… er ... and, networking ... there could be like a little bit of language barrier like "Oh, how will I reach out to people i'm not very confident with my English? Or will they judge me because of my race, or, you know, because i'm not from here they would think this person doesn't know anything about here.*" (P4-S2)

P8, a West African who completed his master's education in an European university with entrepreneurial exposure and opportunities draws out issues concerning immigration rules for international students, and the university having a focused agenda. "*So for you to be able to pursue it further you probably have to leave and go into the realm of entrepreneurship, to be able to, like if we look for instance at the case of Google, even all the cases of all the erm, top companies that are to be created in the US, Facebook and Reddit, they had to leave the university system because of the intellectual property*" (P8-S3). "*So, I think if there was a commitment also from the University to see that okay, one of the goals that we want to set for ourselves is that after one maximum 9 to 12 months, all our students that graduated must have a good paying job over x and x thousand dollars, and you find a way to track it. That will also push every single metric in that direction.*" (P8-S3).

Adjusting to the Canadian Environment

Combined under the subcategory 'Adjusting to the Canadian Environment' are codes covering the elements of the major elements that participants mentioned, either about their own experiences or those of others, in their 'fit' into the Canadian environment as international

STEM PhD students. Some of the emergent codes included ‘Adjusting to Canadian environment’, ‘Noting Canadian academic and cultural diversity’, ‘Contrasting cultures Concerning immigration’ and ‘Challenging relations with people abroad’. The following are some details about each of the codes under the subcategory.

Adjusting to Canadian environment

As international students, most arrived in Canada directly from their home countries. In this study, only two participants, P4 – East-European female who had studied in the United States, and P8 – West-African male who had studied in Europe, signified prior experiences living outside of their home countries. In the course of the interviews participants had to reflect on their experiences about settling into Canada, the university and their research laboratories. These individual participant’s perspectives on fitting into the country were relayed from their experiences. Participants raised the issues of not knowing anyone in Canada upon arrival. “*Yeah, so when when you move to a new country, you basically don't know anyone. I mean, there's probably some lucky people that know a few er people that are here or that came with them, but I think most likely you don't know anyone. And I mean, if you're an introvert, (laughs) that makes, (uses the hands to gesture in a sweeping motion of understanding) like, really hard to … meet … new people*” (P1-S3).

“*Yeah I guess who … Well, I am guessing this can have a impact there because, er, international students need more time to adjust I’d say to a new life and a new environment.*” (P2-S2).

“*I think they* (international students)*, they just adjust, like they just adjust to what it is. I mean … I mean, they have to wait, they cannot say anything about it. So … yeah, I mean, for example … yeah, you have to learn to adapt there is no other way around it. … (pause) … I suppose like this. I mean, if you're international, you've already been through a lot. I mean, not in terms of*

torture or anything, just like you've moved to a new country and everything to a new language, new culture." (P4-S2).

They also raised the exposure brought on by the cultural diversity in Canada, the work culture differences, personal values and the positive impact on students. "*And then being here in Canada, it's it's amazing because you get to know so many cultures and you get to discover, for example, 2 things and how people deal or work. Certain things, and and that's a very (pausing to contemplate) eye opening experience. I think in terms of me, myself, my values, I I feel i'm i'm very strong on that and I i'm open to learn and see but it doesn't mean that, er, that.*" (P1-S1).

"*But once you get here, you find people for in other countries for another cultures, like some, sometimes things that are normal through one culture can be disrespectful for other culture. And talking about certain things is not a good thing, or it's something that is going to annoy other people. So that is a challenge*" (P7-S2).

Beyond the interactions in a culturally diverse environment, participants also expressed their negative experiences with understanding and fitting into the Canadian culture. Differences in attitudinal perception between international and Canadian students was expressed. "*But with them, that's not the case. So that was for me mentally disturbing because I think somebody is my friend … but then that person does something which is not friend related and you're like, (raises voice pitch and frowns) oh my god, I thought that person X is my friend but … they… but (using hand and face to express sudden understanding) and I learned over time like to recognize those things. So no! (starts using emphatic voice in low pitch) They do not apologize because they like they apologize because that's Canadian thing*" (P3-S2 – Eastern-European married female, mother of an infant).

Talking about transitioning into the doctoral programme, some participants compared their adjustment with those of Canadian students particularly in the area of communication and

language. "*I am guessing student… (long pause) … I guess that transition might be easier for …er… er will not be not easy for an international student, I am guessing because there are obvious communication and adjustment issues there I'm guessing, compared to a person who's from Canada, who's born in Canada.*" (P2-S2 – South-Asian male).

Mention is also made of the challenge international students face upon arrival at the laboratory without support to transition into the new environment and learning culture. "*And for international students, it's in, initial is the first time to come to Canada. And er you don't know what you're going to learn or the lab system, they're different, so you need someone to teach you how to start and what, what, where is everything and where you can find everything, wha what do you need? But when why I joined the lab, I don't know any of those people just say hey, this is your bench, this is your cubicle and start your work. And that's how. (Laughter).*" (P6-S1).

Noting Canadian academic and cultural diversity

There was a consensus about the registered diversity in the Canadian academic and cultural diversity among participants. Expressing various experiences, participants data indicated the advantages of the cultural and academic diversity in Canada. "*Huhu! (Rolls eyes and smiles while shaking head) I mean, I will, I must, I must be honest, I, in Canada, I did not run into discrimination. Here everyone has accent or not everyone, most people have accent. And it's kind of encouraged to maintain your accent.*" (P3-S1 – Eastern-European female, married mother of infant, studied in the United States prior to Canada).

"*I mean, Canada is a very diverse country, and I think they're quite used to people from different nationalities working pretty much everywhere across industries.*" (P5-S2 – South American male, married).

"*This Canada Canada is is actually okay. They're kind of more where of diversity and stuff. Yeah, I guess they're okay.*" (P6-S3 – East Asian female).

However, a few participants also picked out some unmet expectations and challenges despite the welcoming diversity of the Canadian academic environment. Specifically, a participant noted the academic and cultural diversity was not being fostered because of lack of systemic cultural integration strategies within the laboratories. "*I will say that there is not too much integration between cultures. We get to work together, we get to respect each other. But as like sharing things like I don't know, outside the university. I don't think we have that. Yeah. And I go… would say that that is important.*" (P7-S1 – South American female).

Another participant noted the need for better cultural network and foundation for international students. "*I'm International. I don't know how things work here. So, a good network and then is a good foundation.*" (P4-S2 – South-east Asian female). A participant also expressed the difficulty of fitting into the Canadian society outside of the university environment. "*So if you are not standing for yourself, the fact that you have accent, will just add up to the fact that people will take advantage of you and try to humiliate you and people do that all the time. It happened to me.*" (P3-S3).

Contrasting cultures

Participants experienced a variety of things as immigrants and some of those were articulated during the interviews. Some of the experiences staying in Canada were relayed about changes to lifestyle, opportunities for career and more. While most relayed personal experiences, a few instances of relaying other people's experiences were recorded. There was attestation to the improved quality of life and income level in Canada compared to home country. "*So (looks towards a window) I would say yeah, altogether. I get it is it's an overall improvement in the*

quality of life I've had back home. It includes the way I eat and the facilities that I get to enjoy, even the recreational facilities that I get to enjoy, and the…infrastructure facilities here, the parks here, the recreational facilities here, obviously yeah, it's also way better (looking thoughtful)" (P2-S2). "*That's what I mean, so I consider myself to be one of the lowest earning groups in Canada itself but lifestyle or the quality of life I have here is way, way better than the same for the same job I will be having back home.*" (P2-S2 – South Asian male).

Participants explicated on some of the differences in the academic cultures they were coming from and the Canadian academic culture. "*We like, back in my country we had to our exams, and that would decide our fate like twice a year. This is more project based, and, to be very honest, particularly, I like that.*" (P4-S2 – South-East Asian female).

Data also identified differences in the career recruitment practices between Canada and their home countries. "*So when I speak specifically about Canada, uhm, what I've noticed is that you don't have to be very highly educated to get a high paying job here*." (P4-S2 – South-East Asian female).

"*Because back where I come from in order to be a biologists, you are quite restricted in terms of what, in terms of who you can work for. Either you work for a government, which hardly ever they hardly ever have openings for biologists, or you go to work for consulting, envo…, environmental impact assessments, environmental studies that are more geared towards licensing for industrial development, which didn't really please me.*" (P5-S2 – South American female).

Concerning Immigration

Immigration is at the heart of activities and decisions of international students in any discipline and state of study. The international student status comes with regulations and rules

these students must abide by during their academic study, and when seeking career options to pursue afterwards. Participants in this study gave insight into some of these experiences concerning immigration for the international student. Most participants commented on how good the Canadian immigration policies are and the attraction this has for international students especially for those who desire to immigrate to the country. "*Canada has a good immigration policy. And one of the easiest ways to immigrant immigrate into Canada is through erm, you know, just come here to study for a bit. You also get some experience of the work culture*" (P4-S2- South-East Asian).

Utilizing their students status as an immigration channel towards Canadian citizenship suggests many students aspire to have Canadian Permanent Residency (PR) as soon as is possible. Data gathered during the interviews give suggestions about the rationale behind the pursuit of PR by international students, and the effect getting PR has on the students' quality of life and career possibilities. "*But the better to have a PR than a work permit. I guess companies look for that as well.*" (P2-S3 – South Asian male). There is an attraction even for individuals who are uninterested in full Canadian citizenship express the value of the PR to students. "*I'm inclined to get a PR, I am not so very hyper to get the Canadian citizenship, as of now. I want to, you know, explore all the avenues. But, I would say it depends a lot where you come on where you come from*" (P4-S2 – South-East Asian female).

The pivotal implication of getting the PR on the quality of a students life is indicated by expressing the change in perception of the students by the Canadian system. "*it matters and so again sound very mean but when you have your PR card, everyone looks at you completely different in in bank in everywhere, everywhere, everywhere because you are considered a part of this community. When you don't have PR you are considered someone you're someone who is temporary here*." (P3-S1 – Eastern European female).

The differentiation between government's treatment of international students and those with PR or Canadian citizenship was an example buttressing such thoughts. "*For example, my friends were international students went on a vacation back to my home country. And COVID happened and they got stuck. So stu… you know, students with the PR or Canadian citizenship were recalled back. But the university, well not the university, the government didn't take any initiative to bring them back. There was a loss in work, there was a loss in… it's very stressful because you don't understand*." (P4-S2 – South-East Asian female).

An additional case was made about the effect when students are facing challenges with their immigration status. "*Some people are just not capable of (glances around) … fighting for themselves and erm, immigration state … immigration issues demotivate students*" (P3-S2 – Eastern European female). This statement also insinuated the need for international students to be willing to 'fight' for themselves, until they attain the PR status.

Challenging relations with people abroad

Data created during the interviews showed participants reflections about their familial relationships. Participants expressed concerns and challenges about managing their familial relationships back in their home countries as international students and how this reflected on their student experiences. Some spoke about the psychological impact of the separation from family for them. "*Um, er, I think it's, it's mostly like, from, from the psychological side, like you, you try to maintain, maintain your relationships with people that are abroad, but you still (smiles) you still need something. So I think that's very hard at the beginning*" (P1-S3 – South American female, completed masters under same supervisor, spouse not resident in Canada). "*And there's harder for us to visit our family takes longer time and everything and for mental health as well because I realized students, it's there … They're like more comfortable, more*

relaxed when they're closer to their family. Yeah, that's what I can think about." (P6-S2 – East Asian female, completed masters outside home country).

The implication of this on having and forging connections needed for finding opportunities was also raised. "*we don't know a lot of people. ... Erm… So, like, we don't have parents, knowing people, having connections, friends as parents, having connections, that kind of thing is specifically for people who are from here. We do not have that kind of opportunity*" (P4-S3 – South East Asian female, no prior work experience).

Summary

With the collation of experiences represented by the 'Experience' subcategories of "adjusting to Canadian environment' and 'Working the triple helix', participants responses indicated the importance of personal experiences and the experiences of others in their perception of issues. They conveyed expressions that signified how these experiences mattered, what those experiences meant to them, and these impacted their views of such matters. Some of the impact expressed where implied while some were directly expressed, a nuance based on the use of language. Overall, these experiences are valid representations of how these students locate career options, career fit, career, expectations, and final decisions.

Defining the conceptual code of Career Thoughts

The conceptual code tagged 'career thoughts' is related to the individual participants expressions of their thought trajectories as international STEM PhD students. Understanding their career perception, expectations and the university's role are condensed under this conceptual code. As newcomers into the country, students expressed their initial career thoughts

when they entered the Canadian environment, and the progression of these thoughts till the point of the interviews. This conceptual code consists of the categories ‘university aiding students’, ‘thinking career trajectories’, ‘internationalizing the PhD experience’ and ‘feeling about PhD decision’ which are explained in detail below.

University aiding students

The code category named ‘university aiding students’ consists of four code sub-categories including itself to explain participants’ perception about the efforts of the university and how these affect their career thought. The subsisting sub-categories of ‘university aiding students’, ‘thinking career trajectories’, ‘internationalizing the PhD experience’ and ‘feelings about PhD decision’ are detailed below.

University aiding students

Out of the eight participants in this study only one person who studied for their MSc. Engineering under their current PhD supervisor had visited Canada before their commencement of the PhD study. This individual had the privilege of a 2-year upstart in Canada relative to the other participants who mostly had between 3 days and 3 months in Canada prior to the commencement of their classes. Such circumstances implied that participants, as with majority of international students depended on the University, faculty, department, and research groups for all information upon arrival into and for eventual decision making and career thoughts in Canada and for their future. Their perceptions of the effectiveness and importance of these university instituted support is converged in this category. Main codes under this sub-category are ‘university aiding students’, ‘awareness of university resources’, ‘communicating, informing

and assisting students by the university' and 'concerning university and departmental impact on career thoughts'.

The data presented by participants spoke about the encounters with the university's resources. Almost all participants acknowledge encountering the university's information resources at the onset of their studies. "*(Long pause) I think, erm, the university has tried to come up with some strategies to help international students … Yeah, so, the university has created like some activities, but I don't think sometimes that's enough*" (P1-S3). "*For example, this job, er, what do you say, career service, career fair, and everything, but it's very generic, it's never for grad students. It's for everyone*" (P4-S2).

Participants commented on the content of their initial engagement and information sessions at the university which was geared to guide them towards academics and governmental requirements. "*It's okay. It's not very helpful, but they tried to tell us what shall we do in our first year mainly, what, what kind of, we need to hand in our SIN number to get paid and we need to have certain credit to finish the requirement and what kind of … we need to look at look for committee members and attend certain seminars to fulfill the first year. For first year all the credits and things and I think they also told us the exams in our second year and third year we need to attend and I think that's it just gave us a daily impression about what we need to do for the PhD. And then they arrange some arrange a session so they asked several professors in each field so they can come to the, come to the session or whatever to tell us what our classes are and give us some recommendation. And that's the two things I remember. For orientation. Yeah, see, it's helpful for new students*" (P6-S3).

While acknowledging this information to be relevant and helpful, participants expressed inadequacy of information for career thoughts, entrepreneurial considerations, and relevant industry and government information requirement to drive career thoughts. "*Ah, I think as an*

international student … I feel that university has given me a lot of resources to get to know about these things, but at the same time hasn't like, there's no … outward effort" (P4-S2).

Some participants confirm the information received at the onset of the PhD study offered no information about job searching and careers which might have been a source of direction for the students, some also acknowledged such information might have been too early in their programme. "*Oh, then it's not that helpful, because we didn't get any information for job searching. At that time. We just arrived and as a fresh student, we didn't know anything. And for for graduation, I think at that time it was still a far topic, so they didn't cover that at all. It just told us okay, this we need to finish this is that program to finish but it didn't tell us how we are going to achieve that* (make career decisions)." (P6-S3).

The length of the information session was considered by some participants to indicate the dearth of information. "*Erm, No, (Shakes head in dismissal and looks upwards while resting hand on her head) when I came I think, the only, I just receive an email about erm meeting in the … I think it was the faculty of engineering. It was one day before classes started. And it was basically one hour meeting and everyone was gone*" (P1-S3). Others expressed how the department and university provided them more information for extra curricula activities while their laboratories did not. "*Laboratory itself doesn't have much influence, but I think university and department has because in order to engage in any extra curriculum activities like volunteering more, you need to have opportunity, you need to know what is out there. So for those purposes, I think the, in my case, the department was the one who provided the most information and I engaged in community work and volunteering work*" (P3-S3).

As international STEM PhD students, data reflected areas where the university's assistance was considered inadequate. "*For example, … career service, career fair, and everything, but it's very generic it's never for grad students. It's for everyone. So, I would really*

appreciate more of that, like focusing on grad students ... And, for a university that has a very good reputation, I think that's really missing. Uhm, but at the same time, they provide us with uhm, you know, Job Fair and career fairs. I'm thankful for that. But I still feel that the focus on graduate students is lacking." (P4-S2).

"*Like for me, entrepreneurship is like giving, like, the possibility like for us, as international students, just (to) know how to like for instance, form a firm, or like all that you need or what are the processes. Like for me, that is the kind of entrepreneurial like or training or support that we should receive, from our, from the university or ... Yeah, like all the protocols and other forms and all the things and the taxes system, like I think the university could educate the students on that regard for those that want to entrepreneur. Yeah.*" (P7-S2).

"*Okay. So, yeah, the orientation is not that helpful to international students for other resources ... but generally speaking, the orientation it's not that useful*" (P6-S3).

Awareness of university resources

Awareness of university resources is a sub-category reflecting data indicating unawareness or awareness of resources available to international students at the university of Alberta. It considers participants' reflections indicating resources available to all students, international students, student career and employability, and entrepreneurship. The University of Alberta has a Technology Transfer Office (TTO), and an entrepreneurial hub designed to encourage and assist entrepreneurial students. The level of awareness of these resources was also presented under this sub-category. Data indicated that some students were aware of the existence of supplemental resources by the school. "… *university system has a lot of, a lot of other supplemental or any other thing to help. Maybe mental health support and every other thing to maybe help international students.*" (P8-S1).

Some participants got to know about some resources because of their interactions with other students who had accessed it in the past. "*But there was one student previously, this was in our group who kind of had a small business venture started up with the help of the university tech office*" (P2-S3).

"*… I mean, I didn't know and I guess I didn't even know there was a department at the University for international students and I learned about that because I met a friend of a roommate that he was aware of aall those things, but I don't think I would have known otherwise*" (P1-S3).

"*Not at all, and I don't think that's because there are no opportunities I think it's because I didn't search around. So it's my fault.*" (P3-S2).

Majority of participants expressed lack of awareness about the existence of the university's resources while others expect or do know about their existence but express uncertainty about where or how to access them. While expressing their various extent of awareness about these resources, some of the participants acknowledge the onus is on the student to search out what is available, but that the school also owns the responsibility for ensuring high level visibility for the said resources. Such visibility is said to be higher when channeled through the faculties, especially departmental level visibility. "*Laboratory itself doesn't have much influence, but I think university and department has because in order to engage in any extra curriculum activities like volunteering more, you need to have opportunity, you need to know what is out there. So for those purposes, I think the, in my case, the department was the one who provided the most information and I engaged in community work and volunteering work*" (P3-S3).

"*Well, I knew at least for my department, specifically, I knew that there was er specifics really quick.*" (P5-S2).

"*You only notice it when it comes through your department more or less, because it's very difficult. It's not a small university. There are 40,000 students*" (P4-S1).

"*Unfortunately, non. (Laughs) Zero. (Laughter) You have to take initiative to get to know about these things on your own. I wish it wasn't like this, but it is. (Pause). I feel it's not their fault as well, because they don't have the time. But I really wish the Department took an initiative for this. I mean, it's very difficult for every individual professor to do that. But the department can do that. Easily. Even if the department doesn't, the Faculty of Engineering can do that. It shouldn't be so hard for them*." (P4-S2)

Communicating, informing and assisting Students by the university

This sub-category evaluated how participants perceived the methods and systems of communicating and informing students about opportunities. They expressed their opinions about how well established and relevant these methods and systems are to them as graduate students. Participants further reflected on how the university of Alberta compares with other universities they are aware of globally. Specifically noting the constantly reiterated lack of awareness about entrepreneurial support for international students perceived by participants, they were questioned about increasing the visibility of university resources on entrepreneurship to international STEM PhD students. Participants were encouraged to consider different resource visibility enhancement ideas for the university's resources.

When asked about the possibility of creating compulsory course programs and trainings about entrepreneurship, business, and TTOs for doctorate students, some participant rationalized students should be given freedom of choice and made to know available options. "… *like it's good, to have them but we already have them. The problem is, they're not reaching to the grad students. I think they need to improve whatever like advertisement, branding, I think, talk to*

supervisors about it. Oh, maybe like we'll send you free passes. You make sure your students go. Just talk like at a very grassroot level that this is for this. I think a lot of your students might be interested in becoming entrepreneurs." (P4-S3).

"*I don't think this is very visible. And it's interesting. I see labs here, they don't write too many patents. When and when I was studying in China and like labs there they try to get some fundings from industry so they will tell some students okay, you don't need to publish paper but it's good if you write some patents. But here it seems people are all publishing paper and not much patent ... I don't think it's on the department website or anything we can look for how to write a patent or what should why we should write a patent.*" (P6-S3).

"*As I said, I don't think they help us through that process. Yeah, and I think that's very important, yeah ... For people who want to I don't know start, like, a startup or something, yeah. But yeah, we don't receive any guidance or seminars or something about that. Especially the legal aspects because, as an international students, we are always worried about that because we don't know how it is here. So we don't want to violate any rule or anything. So it's kind of that is like a barrier for us. To really like entrepreneur.*" (P7-S2).

"*Er, er, I think it's also different when you started in fall, than when you start in winter. In winter, there is not so much, er, there are so many activities to get to know the university or things like that as there are for fall. So that was something, erm, that I mean, I didn't know and I guess I didn't even know there was a department at the University for international students and I learned about that because I met a friend of a roommate that he was aware of all those things*" (P1-S3)

"*I remember I'm going to orientation like at the university, like all majors and our faculties were there. I remember that they used to talk a lot about Canadian culture itself, but not of*

international students and the different cultures. So yeah, I think that is something that we get to know during during our studies and during our time in the university" (P7-S2).

Concerning university and departmental impact on career thoughts

International STEM PhD students who participated in this study made comparative statements about their experience with university and departmental career assistance with their prior experiences at other universities. Direct comparisons were made between experiences in the structure of university and departmental assistance and impact of students' career paths by universities in Brazil, China, and Germany with the university of Alberta.

"*I think we have the capabilities. And I've seen this, like in the university, like when I was studying in Brazil. Like I think we have like the knowledge the capabilities to just start like, I don't know, a consulting firm and that would be like a good thing like as a part time job for the students. That is something that is pretty common, like in other places. And I can't see that in here.*" (P7-S2).

"*... but the graduates system there is optimized for the industry, basically ... STEM practically, like the STEM disciplines there ... you find a lot of opportunities to participate ... as engaged in startups, right, because startups ... get working students opportunities ...(and) ... attract startups towards the environment of the university because they know that even though there's a churn, for at least two, three years, you could get people working on the solution, on this problem and scale ... Like that was the reason why (when) I got the first admission to come to Canada for my masters versus Germany. (It is) the reason I chose Germany rather than doing it in Canada first, because that first experience, because I think if it's a priority of the institution, it will help towards making that happen ... especially for STEM. Alberta is pretty good for STEM*

and disciplines on the engineering side. I think it can work. And international students really benefit from that a lot … A lot." (P8-S3)

"*I see labs here, they don't write too many patents. When and when I was studying in China and like labs there they try to get some fundings from industry so they will tell some students okay, you don't need to publish paper but it's good if you write some patents. But here it seems people are all publishing paper and not much patent … I don't think it's on the department website or anything we can look for how to write a patent or what should, why we should write a patent.*" (P6-S3).

Areas of perceived detachment between available university efforts and the generic needs of graduate students, or specific needs of international STEM PhD students were equally identified by participants. Such areas indicated possible reorganization and planning for better inclusion of these category of students in the university's training and resources agenda. "*Like it's everyone from different universities, sometimes different countries comes and gives a lecture. I wish half of that went to people from different companies to talk about how the work culture is. How can you apply? What kind of profile do you need? Like I really wish it was just specific to … like our field, a little at least a little specific. All the different avenues or even not that like how, if it's the the lectures are for graduate graduate students, specifically. I hope that they, they do have the money. I wish they had the intention to develop such a system for grad students. Or, what different jobs can you do? … Maybe one lecture on how like some entrepreneur who, who graduated from here and built his own system, someone who's in a great post, and he's continued to do research, someone who's maybe a consultant in a really big company who graduate graduated from here. I think that makes more sense to me. But what do I know? (Laughs).*" (P4-S2)

Defining the code category of 'thinking career trajectories'

The code category "thinking career trajectories' is formulated to represent how participants' words during the interviews reflect their career thought journeys from their positionality as international students in STEM PhD programs at the university of Alberta. It reflects participants thoughts about their expectations, how they perceive their positionality impacts on these thoughts and specific implications of being international students in career thinking. Under this category are sub-categories named 'thinking career thoughts', 'career preference', 'describing nice jobs or better opportunities', 'international career trajectory thoughts' and 'looking to learn and grow'.

Thinking career trajectories

Inculcated into this sub-category are participants expressions of how they perceived and processed their career thoughts before their PhD and at present. The sub-categories captures participants expressions about how their thoughts transitioned from their pre-PhD preferences to their current expectations. Data also reflected the underlying desires participants seek to meet with their expected careers. Under this sub-category are codes named 'thinking career trajectories', 'career preferences', 'describing nice jobs or better opportunities', 'internationalizing career trajectory thoughts' and 'looking to learn and grow'. The details about each of these are given below.

Thinking career trajectories

This code is based on participants expressions about the evolution of their thoughts and expectations about and from their careers. Data presented how participants noted their own

progressive thinking about their careers until the point of interview. "*So I am guessing I cannot pinpoint an exact point but it's like if somebody might have asked me a question during my first year, I wouldn't have said yeah, I'm still into academy, I'm still into research but maybe in the second, third year now, most probably I'm up for mostly anything even into industrial jobs even*" (P2-S2).

"*So when I started doing my masters, my career (demonstrating with both hands), my mind, or the career I had in my mind was different because I wanted to go to industry and work … Halfway into the research project, I really liked it (raised eyebrows to look directly at the camera and gave a long pause) … So, but I wanted to like, academics is one option, a job, er, with focus on research is another option for me…*" (P2-S1).

"*… so I ended up choosing or thinking that I would either go towards nonprofit erm, erm, work for nonprofit organizations or work for the government, or erm work as an academic. The academic trajectory kind of started to fall apart soon after I made the transition because I think at that point I started to realize the reality of the, of the job of being an academic and how er…erm demanding that would be so I, I kind of stopped seeing that as a great career trajectory and I'd say.*" (P5-S2).

Career preferences

Congregated under this sub-category are the references participants made about their thoughts about their future careers. Many expressed how they perceived themselves, their career preferences, their reasonings along the path of alternative career thoughts during the course of their studies and in some instances, how they accessed thoughts about previously unbeknown career possibilities. Among the collected data were reflections about how evolving personal circumstances and contexts are impacting on their receptivity towards career perceptions. Data

indicated there were students who were initially unconcerned about immigration into Canada and the implication for their careers when they commenced their PhD program but some others had their intentions set towards immigration from the onset.

"*Erm, when I first came here I basically came to learn (laughs), and I was doing my master and I didn't think about immigration for very much. I was just really open wherever, I wherever I get at the job. I will go as long as it's a good opportunity in terms of personal and professional aspects. Erm, but yeah, I think some people have other motivations, and probably immigration is one of them. But I think that under the underlying concept would be that you are hoping for the better opportunity.*" (P1-S1)

"*… a significant chunk of them just want like to enter the country and this is easy if the if you're smart you can get into grad school. It's much easier to get a permanent residency in Canada, I feel that plays a lot like a significant part. So, I'm sure they don't want to become academician like in a supervisor or teacher or lecturer or whatever. Uhm … Then there's the other kind of like in general, when you enter grad school, sometimes you have a different idea of what it is you think oh everyone will become a professor, but that's not possible. So you change your mind based on what's happening around you.*" (P4-S2).

Some also expressed their initial career preferences for PhD and how they projected that into their career prospecting actions within the ambits of their PhD programs. "*I always wanted to become a part of erm … I never wanted to become a part of academia to be very honest, I don't enjoy teaching at all.*" (P4-S1).

"*Okay. I I have like a lots of … like my my friends and much of the people I know that they already like er finish their PhD, they are working as a research scientists. So I always admired that so much. So I was like, because I already work in the industry, and I usually get so tired of going to an office or going to a place and keep doing the same thing. Every day. So that is*

something that is not challenging from for me. So when I saw that and they keep like so actively researching things and helping other people, and that was like, you know, that's what I want to do. That's what I want to be, that's the place that I want to get there. So yeah.“ (P7-S1)

“*You see, I'm not business orientated person, I will be honest, I am I used to say for myself that I wouldn't be able to sell a black cat to a witch because I just don't know I don't have that business gene (smiling)*” (P3-S1)

“*Erm, I thought that adding a PhD would also give me some advantage over in a market, in a job markets. I thought that would be a benefit in that having a PhD in my CV. Erm … a PhD students or people that hold PhD degrees they can be expected to receive a better pay in the market depending on on your profession or and career…*” (P5-S2)

“S*o, careers that would perhaps give them the most finance financial returns didn't really interest me. I was looking for more for something that would kind of align with my values and it would be er, … erm challenging for my … intellectually challenging, let's say, so ended up coming in and that would like say, have overall societal benefits. So those three, so I ended up choosing or thinking that I would either go towards nonprofit erm, erm, work for nonprofit organizations or work for the government, or erm work as an academic.*” (P5-S2).

“*So I wanted to go more into investment, infrastructure development, which as I said, looking back I really did not need a PhD to achieve it. So still pursuing that is great to have a PhD because of course it so shows a level of dedication to achieving certain things. However, at the same time, I will still want to pursue that independent or irrespective of maybe doing a PhD or not.*” (P8-S1).

Certain individuals expiated on the difference that adequate exposure to information has on the career thoughts and subsequent trajectories students take. “*(Pause) Prr … Erm … Erm … I think deciding on a career path, erm, often time is a function of like information that one has at*

their beck and call, the opportunity that one, that exists around the person … For instance, … I found out very early that in power engineering because of engagement in the industry, that the thing that was really necessary was power electronics, right. But but that was not my interest. But I found out interestingly that all my colleagues that … went into power electronics, even if they had issues with their language, they found opportunities there because … all of them were relatively employed after school without any delay … So our exposure to this knowledge came from opportunities in industry…" (P8-S3).

"*Many people don't think that there are opportunities available. That's because they don't have enough information…*" (P3-S3).

"*…but I'm also be(coming) more open minded. If there are other chances other than doing research, I would take it because one of my colleagues, she gre…, she just graduated and now she works as science communication. So it's like she's not doing research herself, but also we're still stay in science. So I think that I didn't know that before. I thought okay, I study in science I the only thing I can do is research but she told me that's not the only option. So I'm now like, more open minded.*" (P6-S1)

"*Like for example, I just take my example. I entered here when I was an undergrad. I realized during these four years that I am not so much into working in the lab. I took, erm, I did TA ... So because I was exposed to that I realized that I did not enjoy teaching. I do not want to be in the lab. So what do I want? (Laughter) Its not what I would think erm, a supervisor or professor wants to do. So it means I don't want to be that, maybe I want to be on the client facing role of a company. So I think experience and intention both play an equal part erm, in deciding and then there's always like the limited job opportunities*" (P4-S3).

"*But now when I talk to people that I know, a lot of PhDs who have been a part of startup, are getting jobs, they're becoming part of consultancies, they're starting their own businesses. And*

also like they're in the patent office. Er (shaking head) … You know, I even heard that banks are hiring PhDs to deal with certain sectors. And so I feel that in the past, maybe five to 10 years (now)*, I think there are a lot more opportunities*" (P4-S1).

A number of participants reflected on what they aspire towards and desire in their prospective jobs in terms expectations and functions within the careers or jobs. "… (my friends) *have like nice jobs that keep them like active in terms of thinking and learning and challenges. So I think that has given me an idea of also something that I would like once I complete my program. To have a job that gives me the opportunity to learn and grow, and that is also giving me some, erm … how do you call it … chall, mental challenge I would say.*" (P1-S1)

"*The academic trajectory kind of started to fall apart soon after I made the transition because I think at that point I started to realize the reality of the, of the job of being an academic … nowadays, whenever I see whenever I look for jobs, I usually try to look for opportunities within the government or nonprofit organizations that have… that are at least, that have some science in there. That is, that their decisions in whatever they say is either supported or is science based. That's how I um, that's the kind of industry that I see myself working towards. Yeah*" (P5-S2)

"*You might end up with more stressors, more job headaches in my country than over here because there is a better work-life balance. For academics might be the same. The amount of stressors in an academic field will be the same but I would say er, er, er, an industrial job, an r&d job and getting the life work-life balance will be way better.*" (P2-S2)

A few comments about participants positionality and the effect on their career prospects also surfaced as some participants reflected on their circumstances in their view of what they considered obtainable for them career-wise. "(Laughs out loud). *I, I don't know. (looking upwards in contemplation) I mean … yeah I do know. I think being married, would have not posed … erm… a difference, but I think when you have kids, then everything changes. Because,*

that's just the way I see it, your life is not yours. You are the, I mean, yes, you want you want, and you can do as many things as you want in terms of your career. But it's always, er, with the idea of your kids in your mind, and and so, for example, I don't know, I don't think plans of traveling would be that easy or no or I I don't think I will have been able to stay until 11 pm in the lab just doing things or going on the weekends. Thinking in that sense, no, that would have been very different." (P1-S2)

"*And, I mean for of course, a student that finish the undergrad here, erm, of course is, … if you are applying for an entry job level em when you just graduated, erm, that's fine, but if you didn't complete your undergrad here, erm, you will need to, whether do a master so somehow you can validate your other studies. And that will mean you use (laughs) more time over studying. So, I think that that, that could be a disadvantage*" (P1-S3)

"*If, if you are international, employer, … if employer wants to hire you as international, that employer has to prove to the government that there is no Canadian that can do your job (moving body with exaggerated nodding) … So first of all, employers won't bother because that's not cheap. So I think it's around between three to $5,000. So why would anyone pay and then wait to get permission when they can just give an advertisement and find a Canadian that they can hire right now (moves hand in a flourish)?*" (P3-S2)

"*Okay, you need to find a place to settle and that will because you can't move every year when you have family you have to settle at least next 10 years because of school, because of blah blah blah. So now I'm stuck here whatever I do, I'm not going anywhere in next 10 years for sure because* (Child's name) *is here. So, yeah it affects everything. It just (shaking head vigorously) … affects everything*" (FG-P3)

Summary

In summary, this category illustrates some of the factors affecting how these participants, and students, especially international STEM PhD students, design their preferences about their career choices. The options are not simply about what is available or even what they have been opportuned to engaged in but also several additional contingencies which are varied and peculiar to the individuals.

Defining the Conceptual Category "Internationalizing the PhD experience'

Over the course of the study, it became clear that the experiences and consequent journeys of international students differ from, or at least are expected to be different from those of their Canadian counterparts in many ways. The unique circumstances which affect international PhD students especially in STEM and Applied Sciences are congregated under this category. Issues raised herein are factors that Canadian residents or students with Permanent Residency (PR) will not have to grapple with, thus it separates the realities of these international students from those of their colleagues, all other things being equal. The sub-categories under this category are 'internationalizing the PhD experience', 'recognizing language issues, internationalness and context', 'personalising internationalness in personal context', 'intersecting marriage, children and studies for international students', 'internationalizing access to information' and 'expressing most pertinent concern for international students'.

Internationalizing the PhD experience

Participants often expiated on instances and incidences differentiating their experiences and expectations from those of Canadian students. Sometime however, their perceptions indicated zero to negligible differences in their experiences as they journey on their PhD programs. Some of such incidence, validating the differences or indicating none, are under this

sub-category to reflect where comparison might have been made and the perceived outcomes of those comparisons according to available data. Some participant found themselves in largely diversified research laboratories with individuals from various countries and creating a contextual melting pot of culture. The effect of this scenario on the work culture within the laboratories are perceived differently by different participants. "*I think it is a challenge, but it is also something that you are going to use to gain like more skills. You know, so it is a challenge because you just leave your country you're used to like, just people, like with the same culture like you. So you already know how to do that. But once you get here, you find people for in other countries for another cultures, like some, sometimes things that are normal through one culture can be disrespectful for other culture. And talking about certain things is not a good thing, or it's something that is going to annoy other people. So that is a challenge, but at the same time is something that we have to learn and we have to acquire that ability, that skill.*" (P7-S2)

"*… if where you're coming from, if the country you're coming from, you know, even if you don't have that culture of collaboration and or … you come for a different culture and then you get inserted into North America's research culture... If there's a lot of mismatch between those two, you're gonna have issues. … because I think in some cases, I think there's some, some some, some profs or researchers they have, I think they have different expectations if you're international.*" (P5-S1)

"*Well, I think because of the same because of the pandemic because my first year was that like the normal year and you know when international students just came, we are so shy. Like because it's such a huge change is so huge like for me for instance…*" (P7-S2)

"*I think it improves the laboratory culture to be really honest, because I feel because everyone comes to a very different background, its , there is a common topic for discussion and then you learn a lot so you're not stuck inside a room where there's just a limited number of thoughts, and*

like even if we're talking out of context of research, you get to know about the support processes, and I feel that gaining that is … er, it's an integral part of building your own thought process, but also in general your personality, and also because the work culture is so different. Like talking about work, the work culture is so different, at the end of the day you get to learn a lot because there might be something that you're doing wrong and then a person is doing better than you, because they were taught that way and so you can learn that you can take that into account and maybe start following that instead of what you were doing. That's advantageous to you personally." (P4-S1)

Recognizing language issues, internationalness and context

Many international students have English as their second language with various levels of proficiency depending on how long prior to immigration to Canada they have spoken the language, and the local dialects of their mother tongue, and accents with which they speak English. All these factors are further affected by individual language proficiencies. All these affect international students from non-traditional English-speaking countries who constitute majority of our participating international STEM PhD students. Reflections about language concerns, its use, and implications, was presented by participants as both individual. "*So, I am guessing that transition might be difficult for er some people as well. So, er…er, I have another member in our group and there is obvious communication difficulties for him, because the medium of instruction, even the technical terms might have been in their original language* (referring to this other person's language) … *So, erm, it is not for me because the medium of instruction was English for me, where I did my undergrad and Master's so even my school stuff is... So communication wise, I don't feel that much of a problem for me personally.*" (P2-S2, South Asian male).

"*The first thing that when this reflects is on the language base because all international students are not speaking English as er, actually most of international students have English as a second language. Some of us even didn't speak language till late age like I started with er, from the age of 27.*" (P3-S3, East European female)

"*The other barrier might be the language even though you're, when you're going, when you come to get a study permit, you must prove, demonstrate proof of knowledge in the English language. But still, that can be a, it can still be a barrier. If you're not well versed in the English language, that can be a problem. Erm … I don't know depending on where you're from, maybe the, your accent, the skin of hair color, my… the color of your skin … I think there are some implicit bias, implicit or kind of hidden biases in terms of employment …*" (P5-S2, South American male).

"*Well, … you know when international students just came we are so shy. Like because it's such a huge change is so huge like for me for instance, like, like the language barrier was huge. So when I was kind of like Okay, getting more comfortable with that. All this happened…* (reference to COVID-19)" (P7-S2, South American female).

In the data from this study, experiences about accented-ness was not limited to non-native English speakers as participants reflected on theirs or others experiences even when they had interacted in the English language for decades but with a non-Canadian accent. Some reflections expressed include being treated as unintelligent by colleagues, supervisors and the general community which may result in increased reticence in affected students. "*Usually people consider that if you have an accent, you have less knowledge or you have less authority and that is scientifically proven. They did research about that. So if you are not standing for yourself, the fact that you have accent, will just add up to the fact that people will take advantage of you and try to humiliate you and people do that all the time.*" (P3-S3, Eastern European female).

"*But I will give you an example of one supervisor. I will not name him. It's not my supervisor. My supervisor is really nice. So he told one of the international students to get his um thesis checked by someone Canadian, because he was Canadian, because that's the correct way of writing, Canadian English is correct. I mean, I grew up in a country that follows English, British English. My English is better than yours. (pauses and laughs) Like I don't, I'm just saying it for me. So I think that was really racist. And I think it was a little insensitive. Just because I have an accent does not mean my English is worse than yours. I actually am grammatically more accurate than you are, I follow British English, which is the original English whatever you make is just an adaptation.*" (P4-S2, South East Asian female native English speaker).

"*Um … (long pause) …Um, I think I'd make it it makes a little bit more difficult for sure. Um… Especially well, the the first the first barrier is perhaps language for a lot of people. Erm, um, You know, I can speak as fluently as I can my English and people will soon recognize that I am a foreigner. At least from my point of view people will, as much as they want to try to not treat you differently, they they will. It's just it just happens organically. It's it's part of people's mindset it's going to happen, which is okay, I think it would happen to me as well. Erm, …. Um, so that's the first the first barrier that I see.*" (P5-S1, South American male).

"(Participant relayed a personal experience in the US) *I was accused for DUI because of my weird non-American eyes and the weird way I pronounce words and I went for a trial because yeah, that's a really well, like my blood was clean. I didn't have any because I'm not doing drugs. Of course. There are no drugs, no alcohol. Everything was clean. But police officer claimed that I had weird non-American accent and he suspects that I'm DUI because of the weird way that I'm pronouncing words. And I went on a trial for that, jury trial. So that's that's all documented. So it's the it was documented and then I was asked to plead guilty because that would shorten my parole it would facilitate my life and of course I didn't want so I went for trial and that slowed me down for two years in life.*" (P3-S1, Eastern European female).

Personalizing internationalness in personal context

Participants relayed their reflections and experiences within their respective research laboratory groups about how 'internationalness' had impacted them personally or not. They also gave some indications about the underlying individual contextual references to their perceptions. Participants often expressed impartiality in their experiences about work within the research laboratories and departments, negating 'internationalness' within those laboratories. These reflections mostly define supervisory and departmental level interactions with the students and the work culture and interactions within the laboratories, exclusive of interpersonal relations among members of the laboratory. "*I don't see any (shakes head vigorously). Honestly, in here there is no difference. I even don't think about that. It was the issue in US, where I had international students from Bangladesh who was my only friend, because we were internationals and we found each other, but here no. Here its totally … there is really (shrugging and shaking head) no.*" (P3-S1, Eastern European female).

"*I will say the opport, opportunity it's same as a Canadian student because just just once there's opportunity, they will send email out to everyone. So if we are we need some money, we would sign out, sign up. And also for the immigration standards, is same, they sent us everyone send everyone that email.*" (P6-S3, East Asian female).

"*(Long pause) … I … I don't know. I don't know how to respond to that because like once we are in working on our lab, of course, we have like people from Canada, but we are treated the same way and we are exposed to those opportunities in the same way.*" (P7-S2, South American female).

"*Ha! I don't know. Everybody works… I think it's not influencing at all. Maybe erm, out of school productivity, social engagement. Yeah, maybe. Because there's festivals and all those*

things and engagement and religious things yeah, but when it comes to the work that has to be done, er … I don't think that that affects a lot … So the best you can do is engage after your work or even during your work but not core work related. So you interact with a lot of other people that really doesn't matter… In quote, right? And I don't think it should matter because the goal of maybe also going to graduate school is also to meet different people if not you'd have stayed back in your own country. Yeah!" (P8-S2, West African male native English speaker).

However, in data reflecting interpersonal relations and personality differences among international students and their relations within and outside their laboratory communities, participants delved into the impact of personality differences and its effect on international students outcomes. Independent, introverted and extroverted personality types were broadly described as relevant to students adaptability and relational skills as international students. References to these personality types are very broadly defined by individual participants based on their perspectives and perceptions. "*So from that perspective, if international student is extrovert that student will like according to extroverted characteristic will not be scared to speak and since language is living … er not erm not … we usually say in (mother-tongue) that language is alive, it's a live perspective. So language it's a language has to be spoken in order to be better … But if student is introvert, that student will constantly have in mind, Oh God, what if I'm mispronouncing this, what if people don't understand and then that fear will prevent them to speak and that means they will not be able to improve language*" (P3-S3, East European female).

"*In terms of other things, if International Student is introvert that students will never be able to fight for his or her own rights. And of course, language is one of things but the other thing is that if you are an introvert you usually think low about yourself and if you're an introvert who came to foreign country you are already, so to say, 'damaged' because you are kicked out of your country. So that diminishes your self efficacy, self efficacy about everything. So you will*

feel not confident to fight for your rights and very often people will take advantage" (P3-S3, East European female).

"*In terms of other things, if International Student is introvert that students will never be able to fight for his or her own rights. And of course, language is one of things but the other thing is that if you are an introvert you usually think low about yourself and if you're an introvert who came to foreign country you are already, so to say, 'damaged' because you are kicked out of your country. So that diminishes your self efficacy, self efficacy about everything. So you will feel not confident to fight for your rights and very often people will take advantage. … So if you are not standing for yourself, the fact that you have accent, will just add up to the fact that people will take advantage of you and try to humiliate you and people do that all the time.*" (P3-S3, East European female).

Additionally, participants commented on other aspects of internationalness in their personal journeys as international students. Some of these reflections were associated with language and accented-ness. Issues mentioned include shift in work culture, and fit with professors' expectations. "*So first is the language barrier. Then second is the lack of finances … well, the struggles of moving to a new place are like the same always but these two are probably the main ones. And then the third probably is because in this university, we select our supervisor before coming here. We don't really know, we haven't interacted with them enough to know how they are. And so I feel some of us struggle with the work culture. The shift in the work culture is as well. Like I feel like professors should hold a specific group orientation on how their style of work is with all the people they're considering to hire. So that people can make an you know, a known decision, whether they want to join the group, whether it works with their vibes or not.*" (P4-S2, South-East Asian female).

Some participants also gave insight into the impact this has on their job search in Canada as international students: *"…there could be like a little bit of language barrier like "Oh, how will I reach out to people i'm not very confident with my English? Or will they judge me because of my race, or, you know, because i'm not from here they would think this person doesn't know anything about here. Maybe I've just worked here for two years and they think oh, why don't I hire someone who's been here their entire life? Who's worked with… I don't have to take care of who was like, whatever, blah, blah, blah*" (P4-S2).

"*But still, that can be a it can still be a barrier. If you're not well versed in the English language, that can be a problem. Erm … I don't know depending on where you're from, maybe the, your accent, the skin of hair color, my… the color of your skin. My erm … erm, how do I say, another concern, erm … erm sorry but my, I think there are some implicit bias implicit or kind of hidden biases in terms of employment and that sometimes based on your gender, sex or sexual orientation or skin color.*" (P5-S2, South American male).

While others give insight into how this impacts on families with children: "*If they have children like going to the school and it also depends on what is the English level for them because usually the person who is like doing the academic program, we have kind of an intermediate English when we just arrived here, but I'm not sure, an and, I don't know how it'd be like maybe a husband or wife English level. And that… That has a huge impact on how you just live in this country. Because you have to go to school, you have to talk with you that your children teacher … Yeah, so I would say like that would be a challenge.*" (P7-S2, South American female).

Intersecting marriage, children and studies for international students

Some international students are either married or come into the country with their partners and some even have children in tow when they arrive in Canada. Among our participants are a married South American male who arrived in the country with his spouse and both live together in Canada, a female East European female who arrived at a different time from the spouse but both are presently living together in Edmonton, and a South American female whose spouse is resident outside Canada. Beyond these ones, other participants also reflected on their opinions about the impact on international students. Opinions about marriage constituted mixed reviews from participants in our study. "*(Laughs out loud). I I don't know. (looking upwards in contemplation) I mean … yeah I do know. I think being married, would have not posed … erm… a difference, but I think when you have kids, then everything changes. Because, that's just the way I see it, your life is not yours. You are the, I mean, yes, you want you want, and you can do as many things as you want in terms of your career.*" (P1-S2, South American female, married, husband outside Canada).

"*I personally think that I have an advantage for having family because, (looks upwards) you know, science is full of fails (Smiles ruefully and shakes head slightly). Full of wrong hypothesis … I go home and … I … lie next to my husband and hug him. Now I have a child so it's just addition. … Nothing else matters … And then I wake up in the morning and I have an idea how to solve problem. Just like that, that I'm telling you honestly, it's the, it happened multiple times … So people who don't have that, for them failed experiment is tragic. Because everything what they have is that project and you relate that project with yourself and if project failed, you failed (using hand to punctuate each clause)…*" (P3-S2, East European female, married, lives in Canada with husband and kid).

"*But I mean, there's pros and cons to everything. First. You're not alone in a new country. So that's a pro when you come with the family. And if you're a student, you get a lot of benefits for your spouse as well … So I think that's nice, but at the same time, if you consider a case where*

there's a family with only one person, a student and the next, the other one has to look for a job, I think that's a lot of pressure. Because for a family you cannot live in a shared apartment. You need your own apartment at least let's say like a one bedroom. So that's all the pressure is on a student and to the best of my knowledge. Most grad students here don't get more than $15,000 effectively if you subtract the like the money, the tuition fee, and I think that's very hard to make do in that situation. So they have to come prepared. They have to come with a lot of savings here. Uhm, yeah, that's troublesome. I I I imagine." (P4-S2, South East Asian female, single).

"*…it's not just me coming here and I can just rent a bachelor suite or whatever ... So there was always that worry about ... we should be able to get a job in the same city ... We will have to move? ... so there's there are these concerns. ... but that that affected us, I had to stay in Edmonton. There was no other way. So she had to find a job in Edmonton. So we were very fortunate that she she got one and within two or three months she already had a job at the U of A as a postdoc. Um ... (pause) ... Yeah, I think the the biggest problem was the biggest challenge was was finances. I got pretty… okay, um, I was lucky because she, she's also a biologist. She also did a PhD in ecology as same as I am doing right now. So I could always count on her in terms of help, or just discussing things and coming up with ideas. So she really helped me. She was, and I would say that she was my biggest mentor in that case. Perhaps more than whether my supervisor and co-supervisors, and a lot of times, so that really helped um, in my career.*" (P5-S1, South American male, married, lives with wife in Canada).

"*Well, the thing is like most of the international students we are here alone. So, because we are here alone, erm, maybe we don't get to spend so much time with family or you know, when you have, er, children you have to have sometimes, like a good amount of time for them. So I think like I'm, I'm saying most because I know that a lot of international students that have there family here. So yeah, that's that's what I was referring to.*" (P7-S2, South American female, single).

"*I think having a family, it's also kind of stop you from thinking move away from the location you are like I have met some people in my department. They could have taken much better job from somewhere else, but they can't because first Edmonton is more affordable. If they want to go to Vancouver or Toronto, it's really hard to get a same housing as here and they have to give up. So for me, I'm not thinking about like having start a family any sooner because I may want to like move to places with better opportunities. I get just can't take the chance okay, maybe my future partner would say no, like, I want you to stay here and cause all the problems.*" (FG-P6, East Asian female, single).

"*... when I when you said family now I'm talking in terms of spouse, so someone I know is trying to get their spouse from their home country to Edmonton. And they're not taking any jobs. They're not even looking for jobs. They're settling for the RA research assistantship because they have to get their significant other into the country. And so like for me (chuckles), I am appalled at this (chuckles). But I understand their situation, that they're making the sacrifice and there is no fixed date to when the significant other is coming. So they're not looking at jobs. They're not doing anything they're doing like settling for an RA until they come here which they don't know when it is. So even if it's not a child, if it's just a significant other in another country, like you just have to put your career on hold and they're not young.*" (FG-P4, South East Asian female, single)

"*It's completely correct. It doesn't have to be a child. They it's me, me, me and my spouse. We had the same issue when like, I never want like, I waited so long for him to finish his things and that pretty much put my career on standby. And yes, it's especially when you are international you you take what's there and what ... that situation is very common. That what you just described is completely ... it's very rare to have everything perfect where both of you are settling in the same time and things go smoothly. And you get married at the age of 20 and you have children at the age of 25 and and the job and house till the age of 29 that exists in fairytales*

maybe not even there. It just doesn't exist. So unfortunately, it's not live." (FG-P3, East European female, married, lives with husband and child in Edmonton).

Internationalizing access to information

Information and ease of access to it is essential for students and more so for international students who find themselves situated in a new country with new cultures, laws, climate, and policies, and this sometimes with family in tow. The changes these students must make also usually transpires very quickly as indicated by the examples given by our participants all of whom had less than one month to settle into the Canadian environment and school before the commencement of the studies. It is also noteworthy that three of our participants arrived in Canada after the commencement of their classes. These circumstances indicate the necessity of adequate access to valid and reliable information for these students. Some participants reflected on how they accessed, or have accessed needful information from the past, elaborating on information management across all levels of the university to cater to the needs of these international student, and consequence information procurement. "*Ah, I think as an international student … I feel that university has given me a lot of resources to get to know about these things, but at the same time hasn't like, there's no … outward effort.*" (P4-S2).

"*Because many times international students are not aware of they think they have to work like twelve hours so but they don't actually. So even organizing over a weekend or like the evening when the day is over*" (P3-S3).

"*Er … I will say that there's always a level of tension, right? Again, international student because, of course, you're in a different environment … Being an international student also … makes ones to want to take advantage of certain things that may be created at ones environment, but sometimes too uncertain on how to go about that.*" (P8-S1).

In particular, participants also reflected on accessing information about supervisors as international students typically without the prior knowledge or access to professors' relational reputations other than online academic pedigree. "*And I suppose when undergrad students want to become you know, PhD students or, or say masters students, grad students in general, they've been here for a while they know how the teacher works. They know what the students think about them, but for us, it's just a shot in the dark. So that I think is the most where students struggle.*" (P4-S2)

"*I think it's more because in my lab, the reason why we have more international students it's er, he has kind of like bad, bad reputation among students. So all the Canadian students they kind of, they had a chance to visit here and talk to people so they, they heard the rumors, they just go to nicer PI's lab. And for international students, they didn't have the chance before they got admitted. They can't come here and communicate with other people to, er, before joining. So and then once they arrived and as maybe for international students, they feel like oh, if I switch lab, and what if the PI is not happy and then he can screwed me over through my entire PhD and what should I do and should I like then I have to go back to my country and is you know the whole consequences sounds more scary, than domestic students*." (P6-S1).

"*I remember I'm going to orientation like at the university, like all majors and our faculties were there. I remember that they used to talk a lot about Canadian culture itself, but not of international students and the different cultures … I remember one was like how to make friends in Canada. But yeah, they were referring to Canadians that was why. But I would say like half people here are Canadians and the other half is immigrants that can be international students or people that become permanent residents. So, yeah, so … yeah, I don't I don't think like we get that … training or, yeah.*" (P7-S2).

The gap in accessing information about entrepreneurship and entrepreneurial opportunities in Canada for international students was also highlighted. "*Like for me, entrepreneurship is like giving, like, the possibility like for us, as international students, just still know how to like for instance, form a firm, or like all that you need or what are the processes. Like for me, that is the kind of entrepreneurial like or training or support that we should receive, from our, from the university or … Yeah, like all the protocols and other forms and all the things and the taxes system, like I think the university could educate the students on that regard for those that want to entrepreneur. Yeah.*" (P7-S2).

Data further revealed participants' dependence on peers for relevant information and the importance of community groups for international students. "*Er … So what I have noticed is that within the research group … Erm, but more likely than not you naturally go towards people who are alike so if i'm an Indian, I will most likely approach an Indian first. If there's a wide variety of different students in the lab then I cannot do that. I think that's a very good thing. That you reach out to the person who knows more and not who's alike when in terms of nationality, or you know appearance.*" (P4-S1)

"*If you're, if like, if there's if there's no, if there's no big community, community of students from the same the same nationality you are. Or even if there is a community but you're, you, you don't know how to engage with them, let's say, erm that can bring quite a lot of isolation, which will be detrimental to your research and your degree. There, I guess there are also some … other things I guess perhaps international students might question themselves more or doubt themselves more I think I would think because of some of the factors that I mentioned.*" (P5-S1)

"*… when somebody gets an offer or a job, we ask question. "Oh, nice. So what did they ask in the interviews? What did they ask for? What, what are the current things that you could get?" And yeah I think it's common, people do that. I think its really helpful and really essential …*

because some time so the they might also be looking for somebody within their company that has expertise and the individual can recommend you and say, "Oh, so so can do this and this and so, so, so and so"" (P8-S3).

Expressing most pertinent concern

During the interviews, participants consistently expressed matters and issues of concern to themselves. They also often generalized these concerns across the international student community. When asked about what constituted the most pertinent concerns for international students, responses were both derived from personal experiences and their knowledge about those of others. While finance was touted as the most pertinent concern, other issues highlighted included immigration, interactions with family abroad, community relations, among others. "*I, I think I will, I will say like, that can be an economic er concern, like financial. And I think there's also … when at the beginning you don't have a community. SO, I think, I think in the beginning that would be very important, like a concern … Yeah, so when, when you move to a new country, you basically don't know anyone. I mean, there's probably some lucky people that know a few er people that are here or that came with them, but I think most likely you don't know anyone ... Um, er, I think it's, it's mostly like, from, from the psychological side, like you, you try to maintain, maintain your relationships with people that are abroad, but you still (smiles) you still need something. So I think that's very hard at the beginning. And I mean, in any case, it's a change (uses hand in a sweeping gesture), so you need some time to adapt and that also … plays a role.*" (P1-S3).

"*Well, first and foremost, there's the language barrier. I mean, I am, erm I was taught in English. I've been speaking in English since I was five. But I have a lot of friends who learned English right before they came here and they are learning by using and I feel that two years is*

not a good enough time for them to become so fluent in English, although I feel like they've done a great job … Then second is the lack of finances … And then the third probably is because in this university, we select our supervisor before coming here. We don't really know, we haven't interacted with them enough to know how they are." (P4-S2).

"*So there's no one definition, one box fit all, fits all to for international students, but like the basic core values are the same, that erm we're here without family. So we need to be more independent, more cautious. We have limited past networking. Like we don't have a huge like network, then like, then sometimes we look different. Sometimes you look the same, but just the appearance like for example you and I we can tell we're International. We were not born here, but others say from Latin America, they sometimes look similar. Yeah. So and then what stage of life you're in. That makes you different.*" (P4-S3)

"*And um … the other barrier is if where you're coming from, if the country you're coming from, you know, even if you don't have that culture of collaboration and or … you come for a different culture and then you get inserted into North America's research culture... If there's a lot of mismatch between those two, you're gonna have issues … I think there's some, some some, some profs or researchers they have, I think they have different expectations if you're international.*" (P5-S1).

"*Oh, so first financially because we need to pay more tuition fee then Canadian students and also live with we don't have we don't have support directly from our family. And there's harder for us to visit our family takes longer time and everything and for mental health as well because I realized students, it's there … They're like more comfortable, more relaxed when they're closer to their family. Yeah, that's what I can think about*." (P6-S2)

"*I think to adapt to, to the new country. Like in our specific case, adapting to this weather was hard. I think the language is a barrier at the beginning, I think in the academic environment.*

Yeah, maybe because we are not very comfortable … talking a lot, that will make us like feel like behind sometimes. But this is not the case for everybody. So, some people they, yeah, this is like maybe my specific case. And um, yeah, I think that's it." (P7-S2).

Overall, however, the most acknowledged challenge international students generally face as described by participants in this study is financial challenge. Participants express different forms of these financial challenges impacting international students. Some of their responses compared the difference between expenses for international versus permanent residents or Canadian students, while some referred to the additional financial challenges brought on international students during the COVID-19 pandemic. Some of these reflections are captured below. "*Before PR, I was …phew… I had like 30% of my time thinking how I will survive and what if something happens and then I wasn't able to be so focused and I was making more mistakes. Because I was lost in space and time like how I will survive what I will do what we will eat tomorrow, like those kinds of things that are existential, so it affected mentally it just mentally affected me like I'm more, I have more space in my brain to dedicate to my research and that helps a lot (nodding).*" (P3-S2)

"*But it matters because of financial er financials. So that's one thing because when you have permanent residency, your tuitions are not 6000 per term, they're like 1300. So, it's like it's a significant, significant difference … Second of all, it matters, and so again sound(s) very mean but when you have your PR card, everyone looks at you completely different in in bank in everywhere, everywhere, everywhere because you are* (not) *considered a part of this community. When you don't have PR you are considered someone you're someone who is temporary here. … Yeah, having the PR changes everything.*" (P3-S1)

"*First graduate students are underpaid, so that's not something you want to do for long. … But you think about an international student who has no money here, like I don't have huge*

investments or house that I can rent out or anything to anyone. I have very limited means that I'm surviving in, and graduate students are not paid well. It's a written fact. … And, but at the same time I think international students have to work harder because we are just not used to this kind... probably we are not used to this kind of study pattern where you can choose your courses … you know you can decide if you want 5 courses, or if you want 10 courses, this semester. Erm, so I think that requires a lot of hard work, especially with international students who were doing part time (work)*. Erm, I mean my parents, If you do the conversion it's like ₹60 per card, (Laughter) It's very expensive. (Laughs) They can't fund me. (Laughs) So I have to be self-sustaining (Laughter). So, yeah, in those terms I think they… work harder and they're more … they adapt faster, because there's so much pressure*." (P4-S2).

"And then you also say stop…paying them (during COVID-19)*, whatever part time they're doing, that's the money that they used to survive in the country. How are they supposed to manage like some that was very stressful time for … If they don't have finances, they don't have, like they don't have the funding. How will it affect us? You know, international students.*" (P4-S2).

Conclusion

Internationalizing the PhD experience is a conceptual code that reflects the successful efforts by the university of Alberta, through the research laboratory, department and faculty layers, to make the PhD program more international and accommodating to international students. These efforts are noted, appreciated and appraised by our participants and combined with the noted gaps under this conceptual code. According to our participants, there are specific gaps that arise from being international students in Canada, which may be beyond the scope of the university to address but have direct effect on these students lives, studies, mental health and

realities. The additional perceived advantages or disadvantages of these structures for international students with spouses and or children create an added layer to the internationalization experiences of students. Accessing information in ways the international students are familiar with is a necessary binder for the successful integration of these international students into the university.

Chapter 5 - THEORY AND DISCUSSION

Introduction

In this section, the theoretical coding stage of the data analysis is presented. The four conceptual categories, the subcategories, and their properties are used to form a theoretical model. The four theoretical concepts of ‘experience’, ‘career thoughts’, ‘student intersectionality’ and ‘supervisor impact’. These conceptual categories are linked to the theoretical concepts to present the theoretical model. A discussion of the findings is presented to conclude the chapter.

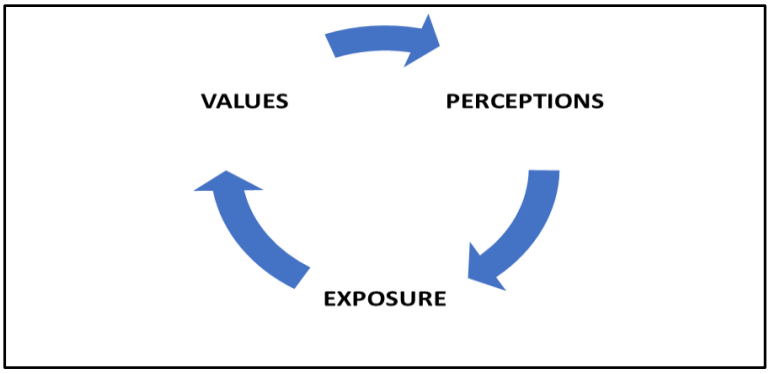
The Main Theoretical Concepts

The main theoretical concepts from each conceptual category are highlighted and analyzed to develop the theoretical model presented at the end of this chapter. The conceptual categories of 'experience’, ‘career thoughts’, ‘students intersectionality’ and ‘supervisor impact’. Theoretical concepts drawn from analyzing the conceptual categories, their subcategories and properties are ‘perception’. ‘personal ambitions’ ‘social expectations’ and ‘identity’, which are all detailed below.

Perceptions

The conceptual category ‘experience’ reflects experiences students had garnered about working within the academia, industry and/or government in Canada. It represented perceptions international STEM PhD students formed directly based on their personal activities and observations, and the expressed experiences of other people. It also represented the perceptions garnered from relationships the students had within and outside the research groups, including prior to their PhD programme. The perceptions about working within the layers of the triple helix are formed by exposure and values.

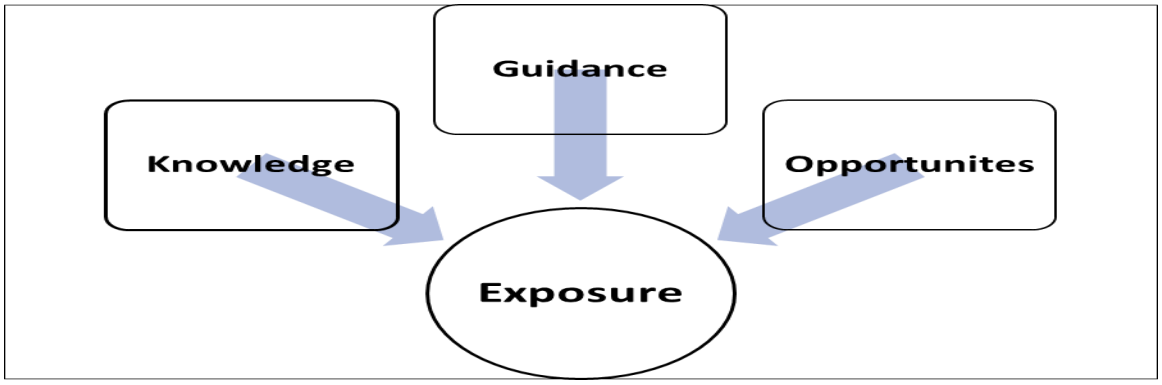
Figure 4 – Perception theoretical diagram



Exposure

The perceptions students formed about engagement with aspects of and the whole of the triple helix, and entrepreneurship, were dependent on the degree of exposure individuals had with them. The degree of exposure these students had engaging with these sectors had great impact on how they perceived engaging with these sectors, and the thoughts of future career possibilities. Some had exposure before and some during their PhD study. The exposure could be because they had opportunity to participate in the engagement process personally or learnt from the experiences of others. Exposure has ‘knowledge’, ‘guidance’ and ‘opportunities’ as its related properties.

Figure 5 – Exposure theoretical diagram



Knowledge

Acquiring the right knowledge about the situation and circumstances is pivotal for successful interactions in any environment. Knowing where and how to obtain information to build knowledge about their new environment is particularly needful for international students as they settle into their environment. Highly visible and accessible systems and structures for the accumulation of knowledge about various sectors and options are requirements for international students. Thus, knowledge is a theoretical property representing how much international STEM PhD students know about (a) Possibilities of engagement with the three sectors of the triple helix – university, industry, and government, and entrepreneurship; (b) Entrepreneurship as an available opportunity for international students in Canada; and (c) How to access government, university, faculty, and department resources in support choices.

Guidance

Guidance represents how students were guided and directed towards (a) engagement choices they may explore as graduate students; (b) necessary adjustments and how this may affect their immigration status; and (c) generating multi-disciplinary and multi-sectoral collaborations that create novel solutions.

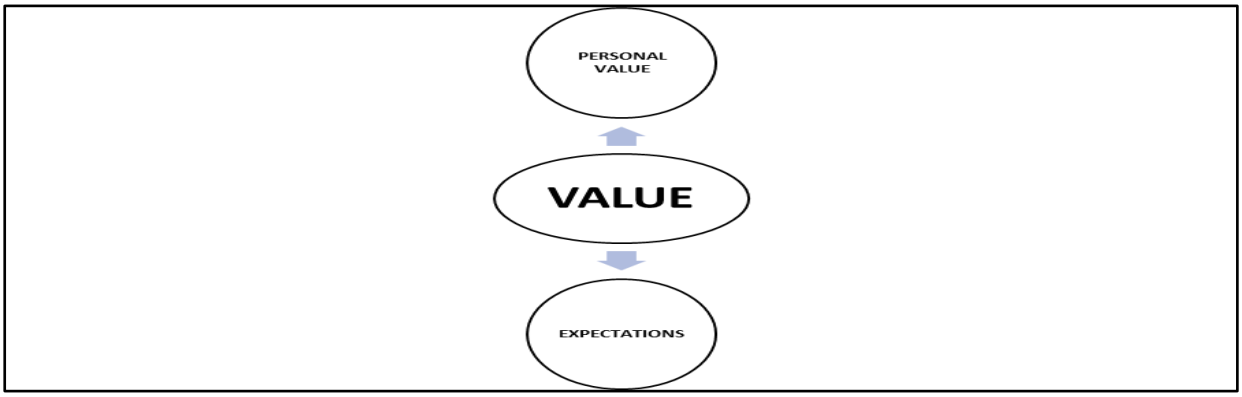
Opportunities

‘Opportunities’ represents how many participants (a) considered what was an opportunity or decided certain opportunities were not viable; (b) viewed limitations imposed by immigration status or financial constraints excluding them from certain opportunities such as entrepreneurship and government career opportunities; (c) found opportunity to utilize their pre-PhD experiences to create opportunities beyond existing research group protocols.

Values

This second theoretical sub-concept under experience is ‘value’ and is related to the correlation of the participants experiences and the values they represent to the international STEM PhD student for decision making. Value in this context is defined as an expression of the

Figure 6 – Properties associated with Values



importance and usefulness inherent in specific actions or attributed to a thing. Participants consciously or unconsciously verify the consonance between their engagement experiences, options presented, opportunities perceived by their understanding of the values these present and their own values. The properties under value are ‘personal values’ and ‘expectations’.

Personal Values

Personal Values is a property of the theoretical sub-category of value and represents how participants attribute value to their actual or expected experiences in their research laboratories. It also represents why and how these international STEM PhD students weigh and calibrate these values and integrate them into the choices they make about engagement and post graduation career decision ruminations. This property answers (a) what is the underlying rationale for wanting work that gives back to society; (b) how do these students adjudicate their personal values are matched by the possible options they are presented with; (c) what are the dominant values for international students in defining what they want to achieve; and (d) how do systemically embedded engagement and work values enable or prevent this, especially for international students.

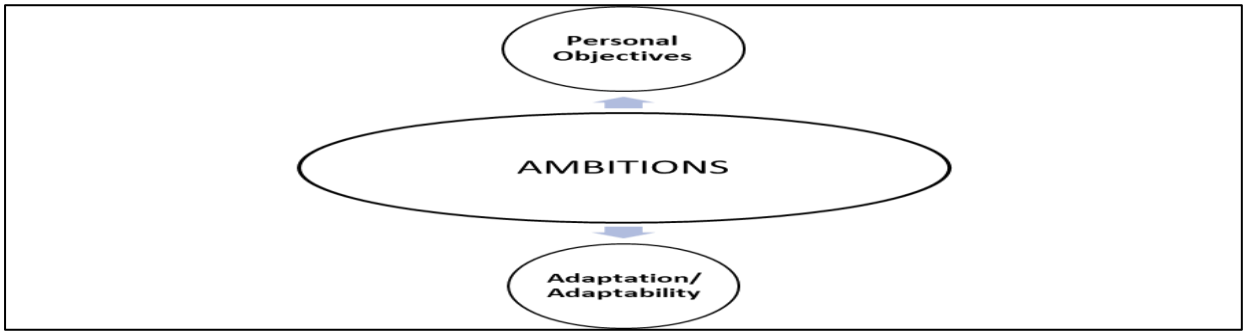
Expectation

This theoretical sub-category is a property of value and represents expectations international STEM PhD students have and expectations that are realistically inculcated into their socialization training at the university. As these students form their networks of prospects, mentors, employers and colleagues, within and outside the university, they proceed with certain expectations in mind. Inability to process expectations in unfamiliar engagement prospects presented to international students forms a variable in their valuation of such prospects and affects their perceptions of such. Managing expectations of international students with engagement will (a) create an alignment in students expectations within the reality of what options exist for engagement; (b) expound available information, resources and opportunity channels with the expectations inherent in them; and (c) fill the gaps between international students' imported expectations and resident realities and expectations.

Personal Ambitions

Individuals who decide to pursue a doctoral degree are expectedly fueled by certain ambitions which they consider obtaining the additional academic laurette as instrumental towards. Prior to commencing on the academic journey to earn the PhD, students expectedly weighed several intersecting variables about their life, dreams, and reality at the point of the decision making. Making these decisions compel individuals to consider their personal contexts, the immigration requirements and implications, their available and attainable resources, based on accessible information. In assessing these information, individual personality becomes an insidious variable in the analyses. In effect, the conceptual category personal ambition is split into 'Personal Objectives' and 'Adaptation/Adaptability'.

Figure 7 – Theoretical concept of Ambitions (Personal ambitions)

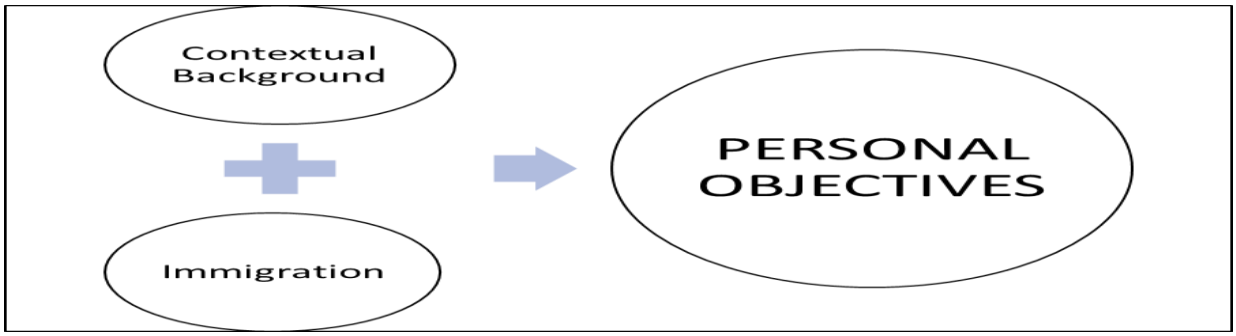


Personal Objectives

This theoretical category is connected to the conceptual category 'career thoughts'. When individuals conceive of pursuing a doctoral degree in any discipline as international students, they consider various aspects of their personal lives as well as the expected requirements to facilitate travel to the country of choice. Consideration is thus given to the immigration policies of the destination country and how to qualify for the study visa, the conditions of the visa, and their understanding about the community, both the university's academic and external social

communities they anticipate. Additionally, individuals contemplate these thoughts together with their anticipated accomplishment with the PhD programs, and their post-graduation career of choice. The desire to fulfil these dreams makes up this conceptual sub-theme. Personal objectives consist of 'contextual background' and 'immigration'.

Figure 8 – Defining properties associated with Personal Objectives



Contextual Background

Individual international students have a variety of circumstances that reflect their realities. Beyond the more apparent scenarios of marital status and parenthood are the more subtle variations created by the exigencies of their culture, family background and other specificities. The difficulty of homogenizing the international student may not be dissimilar to that of the Canadian students, however, these does not exclude the individual differences in their circumstances which are usually exacerbated by being foreigners in a new country. For instance, while the Canadian immigration system enables graduate students to bring in their spouses and family, a participant in the study described the instance of a friend whose career was stalled for more than two years while trying to bring the spouse into Canada after obtaining the post graduate work permit; a scenario that is theoretically unexpected.

Additionally, the circumstances in the individual international students' home country is a relevant factor that affects how decisions are made by the individual during their PhD studies

and afterwards. Some participants acknowledged the availability of a better life quality in Canada relative to their home country. This notion is sometimes directly financial but could also be political as described by participants. Such variabilities in the home country circumstances create differing influences on how and where students direct their career thoughts during and after graduation. 'Contextual Background' answers the questions (a) why did the individual choose to be an international student in their destination country? (b) what in their perception is the implication of going back to their home country? (c) what other relationships and circumstances constitute the individual student's context?

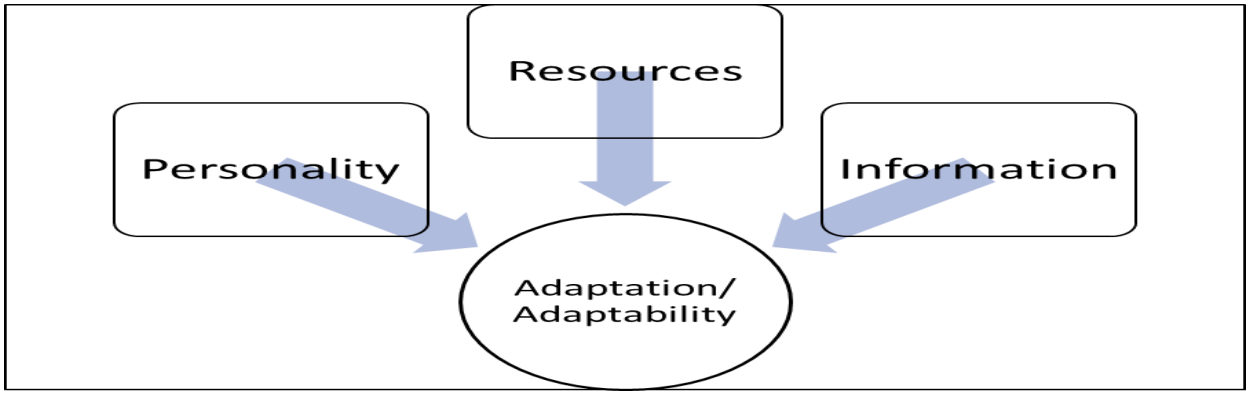
Immigration

Although the generic expectation of study permit condition in Canada is same for all foreign nationalities, there are specific variations depending on student's nationalities. Consequently, different nationalities are issued varied lengths of study visa with varied conditions, in certain instances. This precludes a singularity of immigration experiences for all international students. In addition, the circumstances of immigration per student varies even among those of same nationality, diversifying the experiences and consequent career thoughts of international students. Some students for instance have families or spouses among whom some might have been able to come into the country with their families and others not. The underlying reasons for these variations in immigration could put pressure on these students, warranting they act relatively irrationally, especially with respect to career decisions. 'Immigration' code therefore enables us to understand (a) what are the immigration complexities the individual international STEM PhD student experiencing? (b) what are the particular opportunities for this individual to resolve their challenges? (c) how do these immigration challenges lead to their socialization and career choices?

Adaptation or Adaptability

Adaption into a new environment is a function of individual students' adaptability. As newcomers into Canada juggling fitting into the Canadian community with settling into their research laboratories, rate of adaptation is not constant among students. Various factors affect individual adaptability of international students. Adaptability is therefore a confluence of external and internal factors to the individual. The external factors are eventually combined as dictated by those factors internal to the individual. The external factor codes under adaptation or adaptability here are 'resources' and 'information', while the internal code is 'personality'. All these are further explained below.

Figure 9 – Defining the code Adaptation/Adaptability



Personality

From the data generated in the study, personality differences and their impact on how individuals manage the challenges of 'internationalness' and eventual career decisions. While this study is not a study on personalities, the differences about how personalities affect responses and reactions to many circumstances that do arise or might arise while settling into their research laboratories were identified during this study. When faced with challenges affecting their families either in their home countries or with them in Canada, or the challenges of language and

accented-ness within their research laboratories, or even challenges adjusting to the Canadian work culture and environment, personality types play a role. Eventually, these also have further implications which might include mental health for students.

Resources

'Resources' refers to the material resources required to help international students in their journey from foreigners through 'student-hood' and eventually to career decisions. Resources mostly imply financial resources which are directly owned by these students through own savings or family resources support, or from accessible financial aid through the school, through scholarships, grants participation, research assistantship, teaching assistantship, and part-time jobs. Availability of resources is shown by data to be different from accessing these resources. Accessing these resources were shown to be relatively limited for international students compared to Canadian students. Instances of the differential tuition fee payment between international and local students when employed within their research laboratories and the variation in how this is managed by the principal Investigators is also referenced under this code. Another instance was the variations in the treatment of salaries and assistance packages by the Canadian government to university students during the pandemic. Defining this code gives understanding to (a) how accessible are available resources for international STEM PhD students? (b) how are accessible resources for international students guiding them towards the actualization of the entrepreneurial university? (c) what career adaptations are unwittingly directed towards international STEM PhD students by the accessible resources?

Information

The code called 'information' covers both the availability of information and accessibility of information to international students. International students come into Canadian

universities from diverse backgrounds, with diverse information dissemination and accessibility cultures. The less diverse Canadian information dissemination culture is from the student's background, the easier it is for the students adaptation into their research laboratory and the Canadian environment. Where the divergence is larger than anticipated by the student, this has a negative impact on student's adaptability. This code enables us to answer the questions (a) how do international students access relevant information? (b) how well does university, faculty, departmental and government information for international students converge towards these students accessibility? And (c) what are the best ways international STEM PhD students can access relevant information for fitting into and coping in their research laboratories, with respect to their personal and social lives, and to guide then towards careers of choice beyond their initial perceptions of career availability.

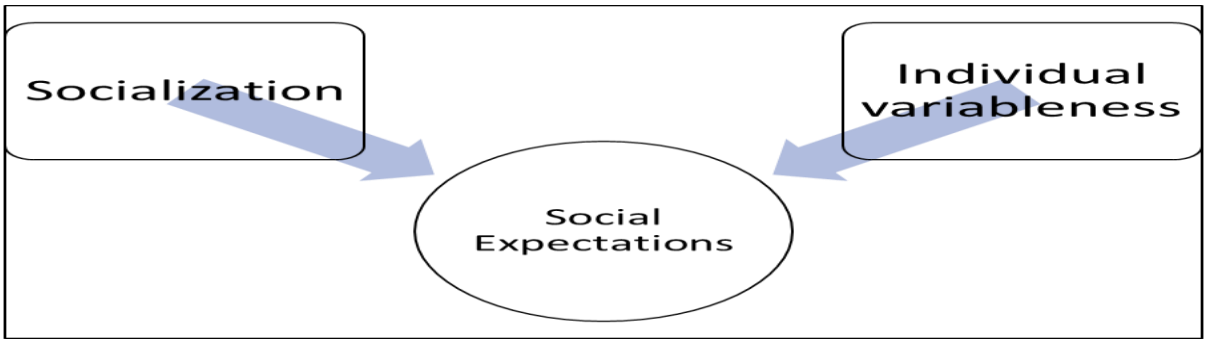
Summary

Internationals students are immigrants in a foreign land who's journeys into PhD studies are built upon their personal ambitions. These personal ambitions draft their initial intention prior to coming into the PhD programs and form their preset objectives. Maintaining or departing from this preset objective depends on the adaptability of the student. Adaptation is accelerated to the extent to which these students access needed information and resources, while their personalities determine how they process these issues.

Social Expectations – The Emergent Theory

This theoretical category reflects the conceptual category 'students intersectionality' and its properties. 'Social expectations' is divided into two subsections that reflect the individual student's own social expectations, resulting from their context, and the research laboratory's social expectations. The subsections under this are 'individual variableness' and 'socialization'.

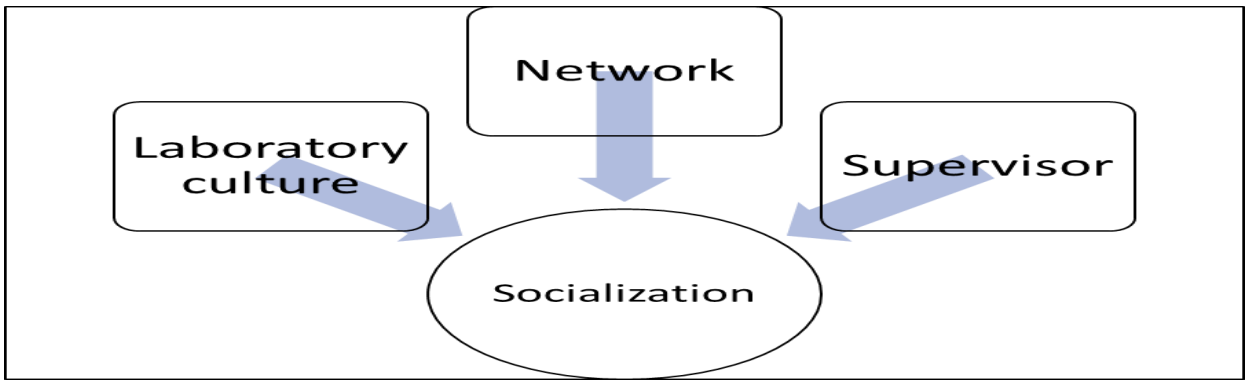
Figure 10 – Social expectation theoretical diagram



Socialization

'Socialization' is an aspect associated with social expectations as it describes the process of culturing students by the academic structures of the school and the research laboratories. Students in general and international students in particular are expected to go through this acculturation process with specific expected outcomes. In the instance of international students the data indicated there are three key properties of importance in their socialization process. The three are 'laboratory culture', 'network' and 'supervisor'. This relationship is depicted in the diagram in figure 10.

Figure 11 – Properties associated with Socialization



Laboratory culture

Laboratory culture includes the hierarchical structures, leadership systems and all relational practices within the research laboratory. The data indicated the relevance of how the laboratory culture influences communication, work culture, mentoring, interpersonal and intercultural relationships within the research laboratory. The inter relationships created among the laboratory members and within the associated community of practice by the established norms within the laboratory, academic and non-academic, are important for guiding the international students towards their careers post-PhD. The laboratory culture answers (a) what is the impact of the laboratory culture in guiding international STEM PhD students towards all possible career options? (b) how do these research laboratories culture international students towards academic and non-academic integration into the Canadian workplace? (c) how well do the research laboratories culturalize international students towards optimal career guidance irrespective of individual variableness?

Supervisor

The supervisor is the principal investigator (PI) in the research laboratory. The PI is responsible for both constituting the laboratory groups and everything that happens or does not happen within the laboratory group. The structure, organization, leadership, and guidance are all given by the supervisor. Mentoring can be accomplished at the research laboratory level by the systems established by the supervisor. Overall, the supervisor is expected to guide students towards the best post-graduation career choices by establishing their academic pathways. Having Supervisor as a property of social expectations shows us (a) how supervisors' established research laboratory culture enables mentoring international STEM PhD students? (b) what are the optimal ways supervisors guide international STEM PhD students? (c) what laboratory cultural norms promote optimal acculturation for international STEM PhD students in Canada?

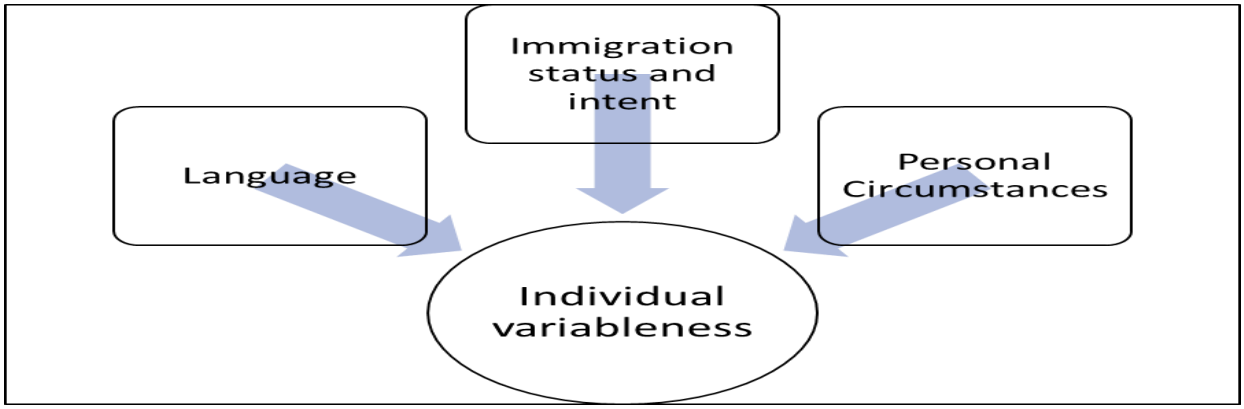
Networks

'Networks' create and promote opportunities for community building, whether academic, social, or cultural. International students build their networks to the extent of their exposure to their community of practice, the social community of students, and their cultural communities. Data from the study indicates international STEM PhD students depend extensively on their research laboratories to aid them in building their academic networks, in addition to self-efforts through social media. Networks as a property of socialization answers the questions (a) what is the best way to help international students build their networks without the implied deficit of being newcomers in Canada? (b) how can networks offer optimal guidance for all career options including entrepreneurship for international STEM PhD students?

Individual variableness

The second property of the social expectations theoretical concept is 'individual variableness' which represents the students' individual attributes and situations. These attributes or situations are the differentiations between students' realities as they move into the Canadian academic environment. It further represents the main but not the only differentiations between these students. The properties connected to this are 'language', 'immigration status and intent', and 'personal circumstances'. Figure 11 represents this property.

Figure 12 – Properties associated with Individual Variableness



Language

The property associated with individual variableness called language represents English language proficiency, accented-ness and use of English language by international STEM PhD students. The experiences chronicled in our data by the participants in the study show the variation in these language qualities by international students of same nationality. It further represents these students experiences with and perceptions of the responses to them within and without their research laboratories, and the ways these affects their fit into the laboratory culture. Understanding this property of language helps us answer the following questions (a) how well prepared are university professors for managing accented students without discrimination? (b) how well do research laboratories and the university structures exist to manage challenges international students face because of language? (c) what affirmative efforts are made by the university to inform international students of available recourse for them?

Immigration Status and Intent

This property represents the individual international students pre- and post- PhD immigration intentions. It also represents the possible transitioning in these objectives and the implication this has on their decisions with engagements and other career decisions up to graduation. Students' immigration intentions affect their views and actions as they progress

through their studies until graduation. This property helps us understand (a) how research laboratories and the university guide students with various immigration statuses and intentions? (b) what systemic accommodations are available to manage international students with various immigration intentions and statuses? (c) what differences international students experience because of differing immigration intentions and statuses?

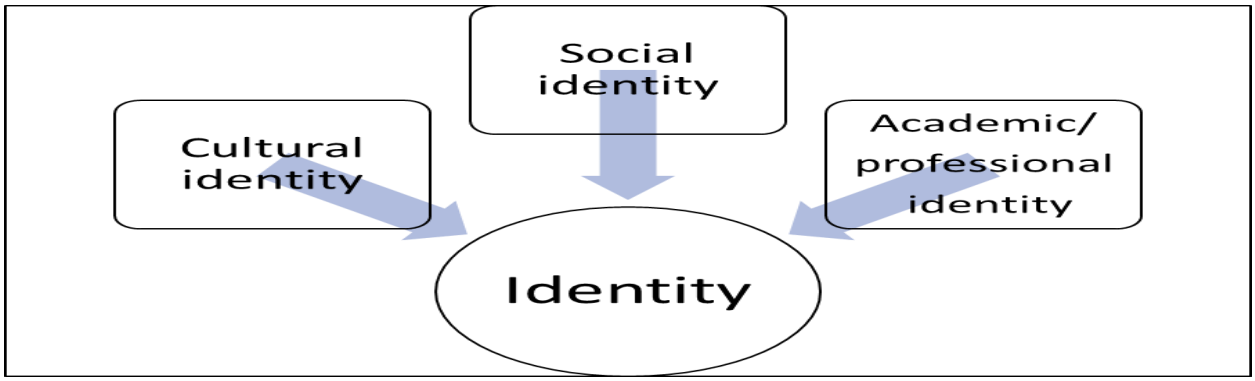
Personal Circumstances

In this property, the different personal circumstances of international STEM PhD students are reflected alongside how these differences affect the students. The differences in personal circumstances include students marital statuses, whether or not they have children, whether the student is in Canada with spouse and children or not, students' stage of life, and circumstances in home country. Furthermore, different students have varied degrees of communication access with their family members back home and this is an addition to their personal circumstances. The different permutations of these personal circumstances have a direct impact on students' social expectations. This property explains (a) how impactful are the personal circumstances of international STEM PhD students on their settlement into the research laboratory? (b) what systemic measures exist to manage and measure support for international STEM PhD students' challenges in their personal circumstances?

Identity

This constitutes the fourth and final theoretical concept. International STEM PhD students' identity in this context is defined perfunctorily as how students perceive themselves within their positional communities. Their identity formation is driven by their interactions with their various communities. These interactions form their academic/professional identity, social identity and cultural identity which represent the properties of this theoretical concept.

Figure 13 – Defining the theoretical concept of Identity



Academic/Professional Identity

Academic identity is equated with professional identity for this study considering it is a study about students forging their paths through the academia into established professional careers within or without the academia. Data in this study highlights the intent of students to learn how to work through establishing their own identities through certain validation. International students in STEM PhD programs express concerns about their ability to develop their academic/professional identities. Understanding academic/professional identities helps us to appreciate (a) why international STEM PhD students exhibit concerns about forming their academic/professional identities in Canada; (b) where the main sources of concerns exist for international students in academic/professional identity formation; (c) how to ensure these students form their identities in accordance with personal aspirations; (d) what is the effectiveness and efficiency level for existing mechanisms for enabling cultural identity in international STEM PhD students?

Social Identity

Establishing a new social identity in Canada is a journey all international students have to navigate. Social identity formation is an essential for students to integrate into the Canadian environment within and beyond their research laboratory groups. It enables international students to find their bearings in their new environment. This property helps to answer questions such as (a) how do research laboratories help to facilitate the development of the social identities of international STEM PhD students? (b) what systemic standards and measures exist to encourage international STEM PhD students as they progress towards forming their social identities? (c) what are identifiable prohibitors for international students forming strong social identities in Canada? (d) how are the Canadian systems helping the students' social identity integration? (e) what is the effectiveness and efficiency level of existing mechanisms for enabling cultural identity in international STEM PhD students?

Cultural Identity

Cultural identity for international students consists of two layers: pre-PhD study and as international students. The latter is built upon the former to the extent that the environment enables it. Building on cultural identity for international students somewhat implies being a cultural and national representative of their people, a situation our data show increases the pressure these students feel. Understanding the ramifications of cultural identity will give answers to (a) how do systemic parameters in the school and in the research laboratories reinforce or diminish international students cultural identity? (b) what implications do affirmative cultural identity formation have for international STEM PhD students' engagement and postgraduation career thoughts? (c) what are significant affirmative cultural identity formation mechanisms for international STEM PhD students? (d) what is the effectiveness and efficiency level for existing mechanisms for enabling cultural identity in international STEM PhD students?

Connecting the main theoretical concepts

The main theoretical concepts identified in the study are "perceptions', 'personal ambitions', 'social expectations', and 'identity'. These concepts highlighted the interpretations and understandings of the international students' experiences and expectations from data analysis. This section serves to explain how these main theoretical concepts are connected and build the explanation around the central phenomenon. This will be geared at showing the interactions between these theoretical conceptions in relation to the International STEM PhD students' career postgraduation career choices.

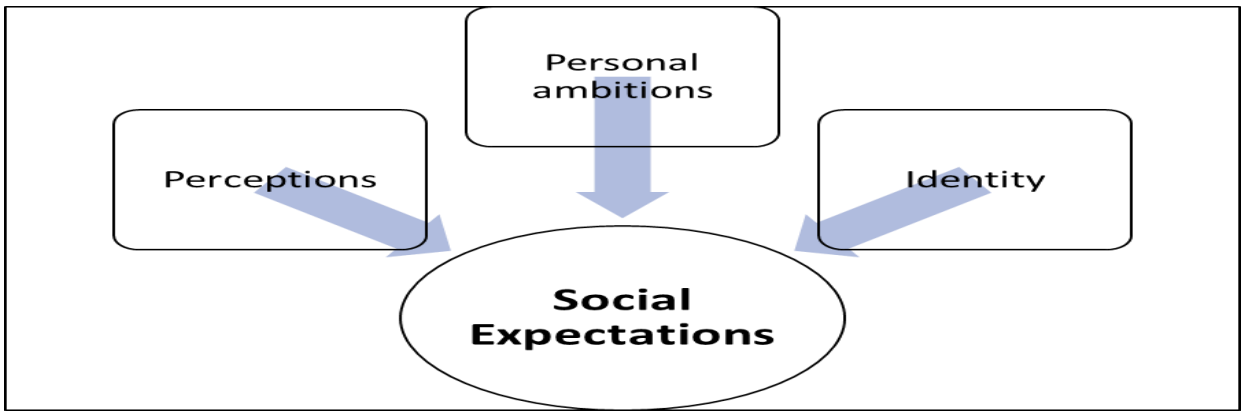
This study was aimed at understanding how international students in the STEM PhD programs were impacted by their research laboratory culture to determine which postgraduation career routes to take. The aim was to understand how the students become aware of the career options between industry/government, academy, academic entrepreneurship, academic-industry collaborations, and graduation. Participants in the study all commenced their PhD studies as international students though a number had become Canadian Permanent Residency (PR) holders with the data showing the difference in how this made a change to their career options perceptions. All participants had experienced moving into Canada and settling down as international graduate students and all had finished at least two years of PhD study at the university of Alberta.

The data indicated that all the participants had certain preconceptions about what they intended to achieve from their graduate education before commencement, some were however more defined than others. The preconceived intentions were a predominant driver for why they had applied to their specific research laboratories. Students' expectations about how their research laboratory matches their ambitions were based on website reviews and email exchanges for international students, creating likely realization gaps upon arrival at the laboratories.

Adaptation of these preset objectives into the realities confronting international students within their research laboratory's culture, the university's support systems, and the Canadian immigration laws, become the student's priority. Prioritizing what would be the most important direction to take will reflect the perceptions of the student, the identity formed and established social expectations.

As students, the social expectations indicated by their individual variableness and graduate student socialization processes become the eclipse over the three other theoretical concepts of perception, personal ambition, and identity. International STEM PhD students harness their perceptions built from their value and exposure, personal ambitions built on preset objectives and adaptation, and the identity they built on academic/professional, social, and cultural identities. This confirms why students immediate postgraduation job choices are either a reflection of their laboratory socialization engagement with academia, government, or industry, or defined by some elements of their individual variableness. This is why social expectations form the central phenomenon of this study.

Figure 14 – Relating main theoretical concepts to the central phenomenon

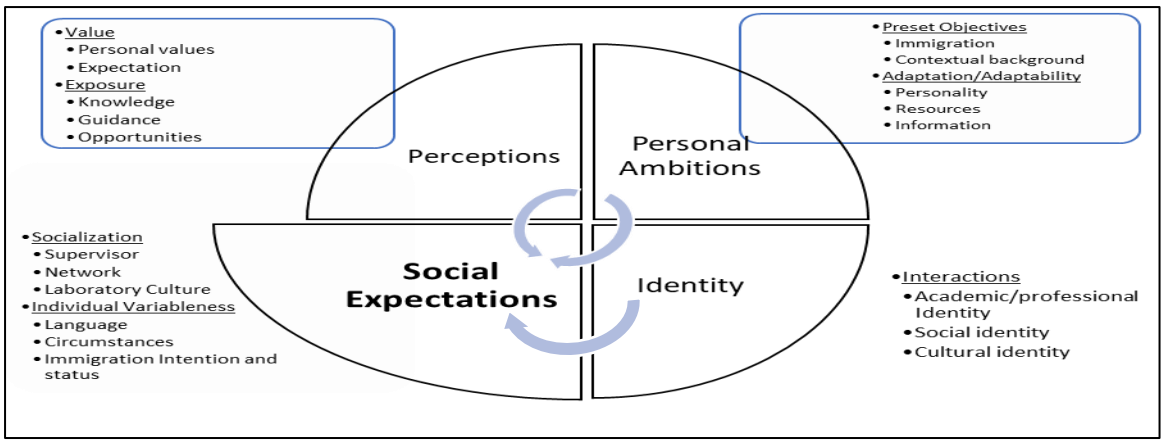


Connecting the other main theoretical concepts is similar to creating a trail or web of the international students processes as STEM PhD students. Students are driven by their personal

ambitions, the properties of which were described earlier, as students commence on their PhD program. As their time in the research laboratory reflects on their ambitions, activities and culture encountered dial into their preset objectives about immigration and personal contextual background, and their adaptability/adaptation because of their personality, the resources at the disposal, and how well informed they are about academic and non-academic realities. These expressly inform the students perceptions of the possibilities based on their values and exposures. Their personal values and expectations define their perception of their research laboratory, their notion about their exposure within the laboratory is derived from the knowledge, opportunities and guidance they think they got. As these students process these occurrences, they are being socialized and forming their identities as international graduate students in STEM disciplines in Canada and resolving their social expectations within the laboratory and in their own lives.

International students in STEM PhD research laboratories reported in data collected that sometimes the representation of laboratories does not match the realities students meet upon arrival, presenting matters around academic/professional identity, social identity, preset objectives, perception, and adaptability. On the other hand, some students get exactly what they anticipated, and others find better than expected circumstances. Students with higher language proficiency reportedly fit faster into the laboratory culture and align more readily with the laboratory culture, denoting the importance of social expectations. Beyond the initial fit, many students reported following the guidance and bidding of their PIs in the exploration of career opportunities, a ratification of the embedded social expectations presented by the socialization process.

Figure 15 - Interconnecting among the main theoretical concepts



Impliedly, the knowledge of most international students remains limited to the types of engagement their laboratory practices. Whereas it could be said that the university, faculty and department provide information that fills this gap, many reported being unable to access such information because of the disconnect with Canadian work culture and information methodology from their background. This bothers on value and exposure that build perceptions, and adaptability as a property of personal ambitions. Such are the explanations given for the generic lack of awareness about entrepreneurship career possibilities by most participants, connecting knowledge, guidance, and opportunity as properties of exposure, and values, both as properties of perspectives. Further in this submission are highlighted two sub-properties of personal ambition namely contextual background as a property of preset objectives, and information as a property of adaptation/adaptability.

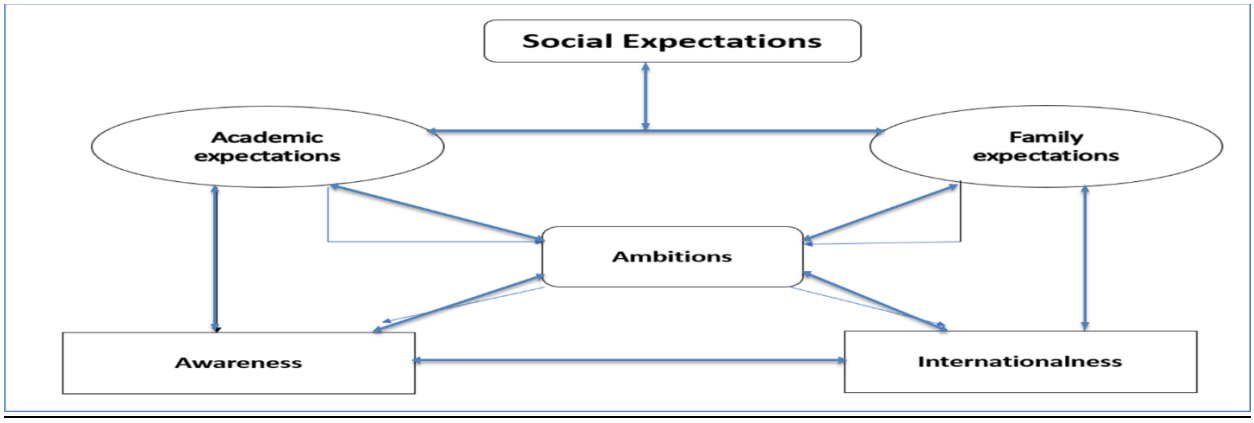
Beyond the laboratory culture fit international students report having to resolve non-academic challenges without the research laboratory's help, reflecting information and resources which are properties of adaptation/adaptability, and the properties of individual variableness, a property of social expectations. Still under social expectation, this also reflects properties of individual variableness. Challenges about family circumstances, immigration issues, and to some extent finances, are generally considered to be outside the purview of the research laboratory except where the laboratory culture creates the opportunity for such discussions. International PhD students mostly surmount these challenges before they graduate but sometimes not.

The stage in the life of these students are similar to those of other students within the laboratories and being in long term marital relationships is not unusual, neither is being parents. However, international students report additional challenges including inability to access loans, getting jobs for partners and childcare, language proficiency challenges for partner and or children, and immigration problems, are unrelatable for non-international students and supervisors. Having a spouse or partner come along into Canada is however rated as an advantage for emotional and mental support, and for early access to permanent residency for couples who have no immigration challenges. These are reflections of the individual variableness property of social expectation with sub properties of immigration status and intentions, personal circumstances, and it is also about identity formation and its social and cultural properties.

As shown above, all the main theoretical concepts indicate an interweave that reflects the complexity of how individual international STEM PhD students navigate their choices. Connecting these theoretical concepts to show this interweave as the international STEM PhD student comes into, settles at, and continues towards graduation in Canada, and specifically at the university of Alberta. The next section explains the theoretical model.

The theoretical model

Figure 16 – Describing Main Theoretical Model



The international STEM PhD students' reported experiences represent different facets of their socialization process as foreigners in Canada, in a Canadian university, sometimes with spouse and family, settling into a new research laboratory and learning culture. The socialization process for individual international students goes beyond the research laboratory or the school into extra curricula spheres. As the students go through this socialization process, they report experiences within and outside the academia, presenting the effects these have on their outlook towards postgraduation careers. As students' journey through their socialization processes, expectations about what, where and how they may proceed in their careers are built for the academia and the family. Understanding and explaining this theoretical model helps us to understand this.

Social expectations

The theoretical model in Figure 14 shows that social expectations built during the socialization process of international STEM PhD students fall into two categories, academic and family expectations. These expectations represent the expected outcomes of the international students' tenure in the STEM PhD program. Expectations are formed both by the students themselves and by the academic and familial relationships of the individual student. Familial relationships are not only about the marital status of individuals but also about the circumstances in the extended family of said individual. This model is a recognition that all the conceptual categories aim to build the individual student towards certain career ideals. This is why there is expectation about the types of jobs individuals with certain levels of education works; why there are certain expectations on the level of knowledge and intelligence they exhibit; and certain expectations about their demeanor in society. Similarly, with families of these international students they have expectations about the outcomes of their academic attainment and its impact on the extended family, the spouses, and other relationship connections, depending on the

cultural and social backgrounds. All of these expectations are forged into the individual international STEM PhD student's aspirations: their ambition.

Academic expectations

Interactions within and without the research laboratory, the culture, leadership and engagement the international student has experienced are the student's introduction to what the Canadian society can offer in academic, industry or government career expectations. The experiences of adaptability and adaptation arising from individual differences such as language proficiency, accented-ness, financial situation, social and cultural fit into the laboratory, all affirm in these students what career aspirations to nurse. Over the course of their work within the research laboratory, the students decant direct and subliminal expressions of affirmation or refutation of individual proficiency in the Canadian environment. As students navigate these academic socialization experiences, their perceptions of these experiences are channeled towards building their academic, cultural and social identities in Canada. The identity they build defines their career expectations as they graduate from the program, irrespective of whether they choose academia, industry or government work. The extent of their engagement scope while in the research laboratories form the extent of their postgraduation career aspirations.

Upon their arrival into Canada, the international students are equipped with their previous knowledge of postgraduation career possibilities. They also have preset ideas about their receptivity by and adaptability to the Canadian work culture. These expectations are amended over the course of participation in the PhD program. Amendment of these expectations occur owing to the individual's direct experiences or peer experiences and outcomes. International students often reported deferral to peer intelligence within and outside the research laboratory for information and assistance. Information, perceptions, and experiences so gathered

by these international students become their window into how, where and what to target in the postgraduation career. This becomes the students' ambition.

Familial expectations

International students come from diverse family relationships similar to Canadian students. However, the dynamics of family relationships are based on cultural, societal, and ethnic values. In certain circumstances, religion plays a non-divestible part in many international students' familial relationships. Additionally, individual students come from various walks of life, stages in life, and marital circumstances, denoting a variety of expected outcomes for each student postgraduation. Some of these international students are married, some choose to immigrate with their partners and families, others not. Also, among those who are unmarried, specific cultural, societal, familial, or religious realities are predicators of postgraduation outcomes of the students. These are additional non-academic layers of identity and perspective that international students build into their postgraduation career expectations.

International students' familial realities and challenges are non-linear, neither can they always be predicted. Range of matters that affect international students' expectations include loss of loved ones, changes in family circumstances at home, immigration challenges for self, spouse or children, settling family into the Canadian work and academic environment, and finances. Mostly these issues are known to students before their PhD studies but often the saying "life happens" presents. These realities, preempted or otherwise, form part of the additional socialization of international students who must inculcate these realities into their perceptions, identity formation and subsequent ambition building.

There are also instances when the international student's journey through PhD indicate the dominance of their academic socialization resulting in more grounding towards academic expectations than familial. This is the usually expected scenario for students generally. However,

sometimes unexpected changes in the familial circumstances present, suddenly tipping the expectation scales in favor of familial expectations. The magnitude of such occurrences and the effect on international students usually weighs heavier than for permanent residents (PR) holders and citizens. Basically, difference in access to community, financial, immigration, and culturally appropriate support when such challenges occur exacerbates these challenges for international students, unlike their Canadian or PR holder counterparts. Evidence of such differences was reported by students to be the differential treatment dealt to students on study permit during the pandemic, compared to PR holders and Canadian students.

Ambitions

Prior to applying into the STEM PhD program, students generally have preset ambitions they seek to pursue. These ambitions are fed off of preconceptions about the PhD program, the research laboratory, university and expected outcomes from the program. Students also put their familial and personal circumstances into consideration, projecting known realities of their circumstances into thoughts about their expectations. These expectations are formulated into specific ambitions. As the students progress through the STEM PhD studies, additional realities from their socialization at the laboratory and any change from anticipated familial circumstances amend the ambition of the students. The extent to which the socialization experience at the research laboratory presents new realities, and the changes or adjustments at the familial level lead to adjustments in students ambition.

Whereas the overall academic socialization experience at the research laboratory has direct implications on the student's perceptions about possible career possibilities and expected outcomes, familial circumstances changes may be subtle and gradual, or sudden. In many instances of these alterations in familial circumstances the international students are compelled

to rely on peer knowledge as research group leaderships are unable to assist for various reasons. In addition, where students do know about and can access university aids for these familial changes, the uniqueness created by cultural differences or language challenges may prevent them from obtaining needed assistance. Depending on what constitutes these changes, irrespective of the magnitude of change, some of those changes have no impact on students' ambition and expectations. Ability to maintain the ambition projected by academic and familial expectations are therefore directly related to the individual students' level of awareness of resources, opportunities and possibilities, and the level of 'internationalness' of the student.

Awareness

In this report, awareness is defined as having the knowledge about the existence of resources, helps, opportunities, knowing where, when, and how to access such, and feeling comfortable about accessing it. Awareness in this regard excludes presumptions, perceived knowledge, or unattainable knowledge. This then presses the significance of access into this definition of awareness. International STEM PhD students in this study mostly reported lack of awareness about what is available. Complete information about available resources may be made available by the research laboratory or the university, but effectiveness depends on awareness. A lot of disconnect between resource availability and awareness is a result of cultural difference between the Canadian academic, work, and information culture and those from which international students originate. Among some of the students, accessing information outside of certain sources invalidates the information as a result of their contextual backgrounds. Such students cannot relate when information sources are outside of their preconceived sources.

Altogether, awareness bothers on the system of information dissemination utilized by the different levels of the university and research laboratory to ensure information is received about

crucial aspects of the resources necessary to having a wholistic view of opportunities, resources, channels, and interventions. Assuming international students have a global view of available postgraduation possibilities beyond what they are exposed to, or assuming they could not have career interests beyond those actively pursued by the supervisor may be ridding students of their maximum potential, and ridding the university of the dividends of students diverse interests. Adequate awareness strategy is particularly important for international students to understand and partake of the entrepreneurial university model. It is the way they can learn how to navigate the Canadian systems within the context of all career options.

Internationalness

International students' main distinguishing factor is their 'internationalness' or foreign student status. Internationalness is defined here as every attribute of life, living, perception, interpretation of opinions and ideas, and any other nuances that separate them from their Canadian counterparts. It includes their unique circumstances, immigration status, beliefs, values, ideologies, religion, work culture, study culture, and any other things that differentiate them from Canadian students. Internationalness and associated traits are not limited only to students with study permits but also include those who commenced their studies as international students but have become permanent residents.

Internationalness is the unifying descriptor for action, reactions, expressions, behaviours, and thought paradigms peculiar to international students but not Canadians. Internationalness can also distinguish between newcomers and settled Canadians of the same nationality and ethnicity. It reflects questions, uncertainties, and surprises of international students about the ways, manners, and living experiences within the Canadian society, and the research laboratory. Internationalness affects how and what information international students may consider

verifiable, how they expect information to be disseminated, how they expect to seek information, how they interpret local law and customs, their interpretation of rules, laws, policies, and lack of knowledge about them. It is why Brazilian international students will preferably seek information about taxation or immigration from an Indian or Chinese student than from a Canadian. It is a property that establishes how the social expectations of international students direct their ambitions.

Discussions

This is the theoretical model representing the findings from this study of how the research laboratory culture impacts international STEM PhD students' decisions about postgraduation career paths. The model was developed from the key theoretical discoveries in the study: 'Perceptions', 'Personal ambitions', 'social expectations' and 'identity'. The qualitative study used a Constructivist Grounded Theory approach and collected data primarily using semi-structured interviews in addition to a focus group session, and general demographic information using questionnaire. The theoretical model conceptualized the perspectives given by the international STEM PhD student participants in the study and is the main contribution of this research. Evaluating the theoretical model is necessary to validate the relevance and traction with the research question.

Evaluating the theoretical model

The developed theoretical model relied solely on the outcome of the constructivist grounded theory analysis of the data from the study. Evaluating the theoretical model will bring to bear the inherent strengths and weaknesses of the constructivist grounded theory methodology since the analysis outcome produced the theoretical model representing the perspectives of international STEM PhD students. Iterative coding of the data resulted in conceptual codes and

eventually theoretical codes which formed the bases for building the theoretical model. It provides a summation of the data created by the participants about what affects their career decisions. The model may be considered as a subjective or limited representation of international STEM PhD students' perspectives, a generic bias in qualitative studies. This subjectivity is further explored in the section on study limitations.

Connecting Theoretical model to literature

The theoretical model created from the multi-stage coding of the data created in this study will be linked to literature in this section. Connecting the theoretical model to extant literature gives depth to the findings, authenticating the model. Social expectations in the model consisted of both academic and familial expectations. Expectation in this paper is used to imply the outcomes anticipated by individual international STEM PhD students because of their effectuations about their circumstances. The presence and relevance of these expectations are in students' career thoughts as reified by authors including S. Anandavalli (2021), Anderson, T. (2017), Avenido, K. (2023), Elemo, & Türküm, (2019), Fariah, et al., (2023), Pepanyan, et al., (2018), while Janssen, et al., (2020) talks about the pre-emptive expectations supervisors have in their PhD students. All these ramifications of expectations are aggregated under social expectations in the theoretical model above and are bifurcated into academic and familial expectations.

Academic expectations in this model represents expectations built about postgraduation career possibilities available to international students resulting from their perceptions about the socialization experiences in the research laboratories. Experiences within their research laboratories, engagements in collaborations within the academia, with industry and government, perceptions about how the supervisor and laboratory members reacted to their language proficiency and accented-ness, career patterns reflected by the other PhD students from the

laboratory and department, dominate these expectations. How these experiences percolate into the individual international student's academic identity formation is a self-sustaining loop of validation and aspirations. Bienkowska, et al., (2016), Bienkowska & Klofsten, (2012), Cason, (2016), Janssen, et al., (2020), Thune (2009), and Thune, (2010) relay some of the tensions generally faced by doctoral students without bias for being international.

Academic expectations, as described earlier under findings, are a multi-spoked wheel consisting of expectations formed, pre-, during and post, research laboratory membership by the individual international student, international laboratory members, Canadian (local) laboratory members, supervisor, members of the research laboratory's department, school faculty, university, and other academic communities of practice. Janssen, et al., (2020) present a didactic from their study about student-supervisor relationship expectations in the areas of autonomy, competence, and relatedness between doctoral students and their supervisor. Relational preconceptions in academic interactions between international students and supervisors, international students and local students, and international students and staff, are highlighted by Montgomery (p. 26) about their study of international postgraduate students in the United Kingdom. These preconceptions affect attitudes underlying relationships across international students, staff, colleagues, and supervisors (Montgomery, p.26).

Relevance to the Theories of Career Development

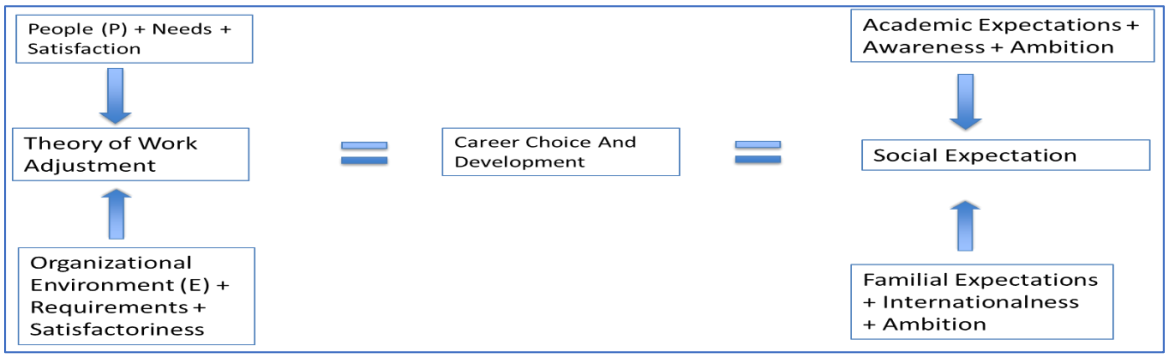
Evaluating the emergent theory of this paper in the light of the five career development theories described in chapter two helps to determine whether the theoretical model fits into the theories. It also helps evaluate which of the theories best reflect the findings of this study. Noting that career development is a process helps us understand that it develops over time, and that career does not imply which occupation individuals commence with but how they progress

through to their occupational peak. Consequently, the emergent theory could be representative of a postgraduation career development theory for international STEM PhD students at the university of Alberta. It must be noted though that the study simply seeks to find connections, where available, between the emergent theory of this study and the proffered career development theories. Considering the career development theories as elucidated by Leung (2008) and Osipow & Fitzgerald (1996), each of the five theories will be compared with the emergent theory above.

(a) Theory of Work-Adjustment (TWA)

This is also called the person-environment correspondence theory because it is anchored on the individual difference tradition of vocational behaviour (Leung, 116; Osipow & Fitzgerald, 182). Relating TWA to the emergent social expectation theory is done as depicted by the diagram.

Figure 17 – Theory of Work Adjustment and Social Expectation

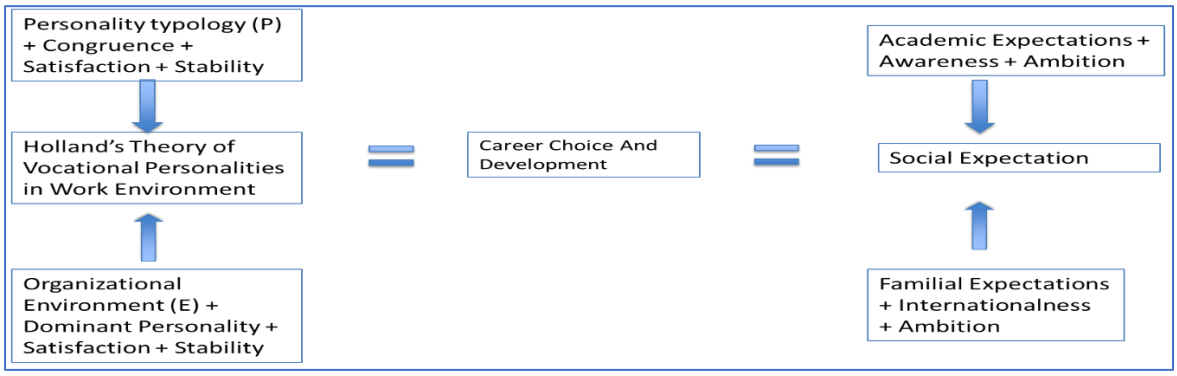


(b) Holland's Theory of Vocational Personalities in Work Environment (HT)

HT postulates that vocational interests are an expression of personality and interests for individuals. HT is a conceptualization of six typologies of which the dominant one indicated that the vocational environment dictates the attitudes and values the people express (Lalina, p. 2; Leung, p.118; Osipow & Fitzgerald, p. 76). In essence, the fit of the dominant typology creates

vocational fulfilment or dissatisfaction. HT thus implies the personal typology (P) seeks congruence of the organizational environment (E) for stability and satisfaction, and the organizational environment (E) seeks who share the characteristics of its dominant typology in their career interest for stability and satisfaction (Lalina, p. 2).

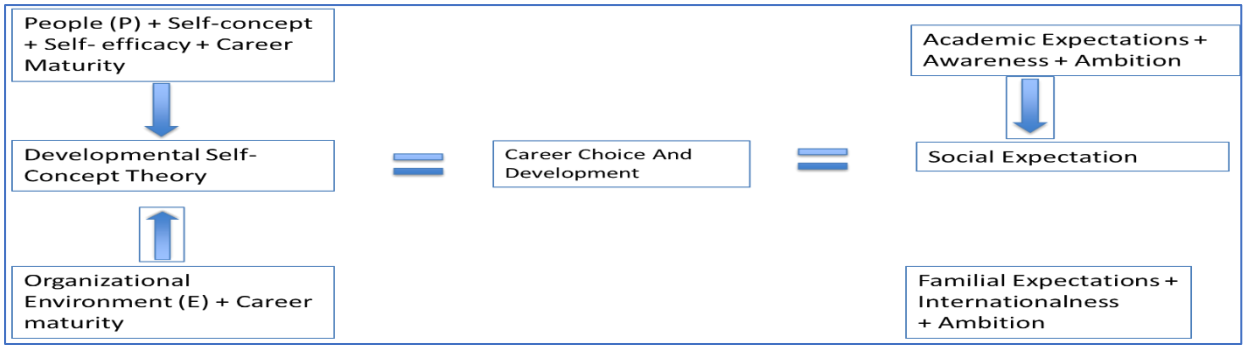
Figure 18 – Relating Holland's Theory and Emergent Social Expectation Theory



(c) Super D. W's Self Concept Theory (SCT)

Super postulates that career development and implementation are a person's self-conceptualization process. SCT suggests that an individual's self-concept is a product of complex interactions of factors including growth, personal experiences, and environmental characteristics and stimulations (Lalina, p. 8; Leung, p.120; Osipow & Fitzgerald, p. 111). SCT says that the more a Person (P) matures, their self-concept stabilizes, and they choose the careers most likely for their self-expression at their stage of life (Lalina, p. 8; Osipow & Fitzgerald, p. 111). This is also referred to as career maturity (Lalina, p. 8), relaying that people's (P) social contexts are reciprocated in their choices of work environment (E) (Lalina, p.121; Leung. P. 120).

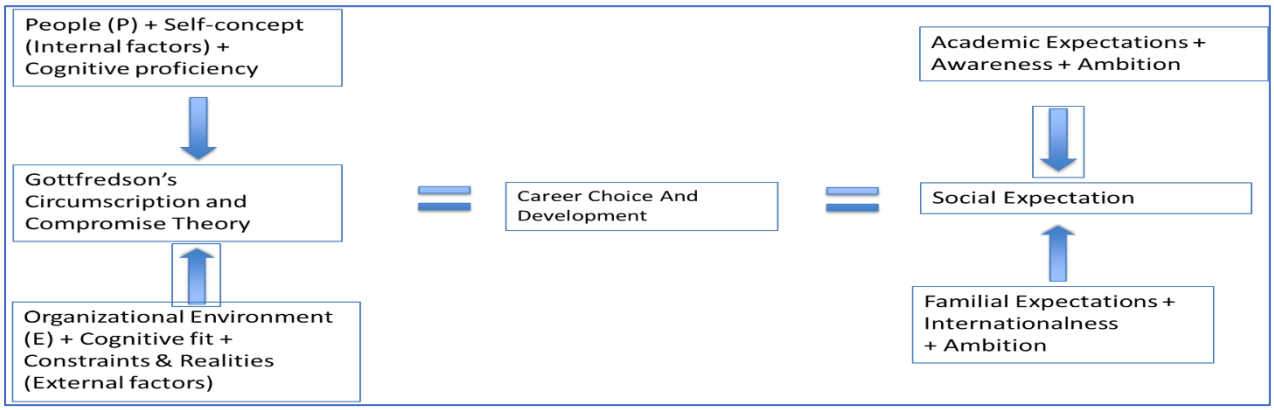
Figure 19 – Self-Concept Theory compared to Emergent Social Expectations Theory



(d) Gottfredson's theory of Circumscription and Compromise (CC)

This is also called Career Compromise theory (Leung, p.124). CC basically suggests that as personal cognitive proficiency improves, the process of elimination or circumscription of career alternatives also improves (Leung, p.124). Self-concept is formulated by both internal and external factors weighed by the individual's developmental stage in life (Leung, 123). Individuals with developed self-concept use compromise in response to external realities and constraints as they shape their careers. Therefore, CC implies the person (P) eliminates and chooses career or vocational environment (E) alternatives that match self-conceptions resulting from their assessment of internal and external realities and constraints for compatibilities.

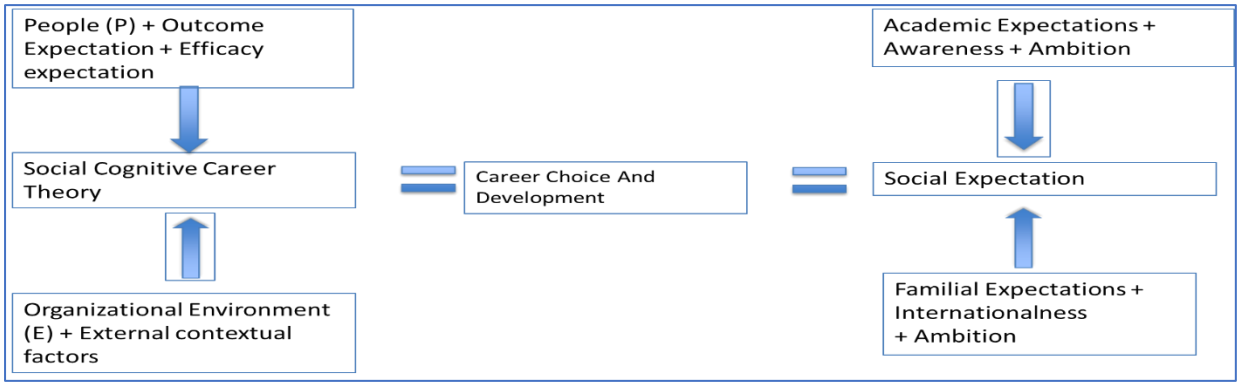
Figure 20 – Relating Circumscription and Compromise to Ermergent Social Expectation Theory



(e) Social Cognitive Career Theory (SCCT)

This is anchored on Bandura's self-efficacy theory (Leung, p. 125). The SCCT is a co-created reciprocal relationship construct between people (P) and environment (E) which is centered around the three core variables of self-efficacy, outcome expectations, and personal goals (p. 125). The summary of the study portends a person (P) determines the work actions and environment (E) where they have control by their level of self-efficacy (p.125).

Figure 21 – Relating SCCT with the Emergent Social Expectations Theory

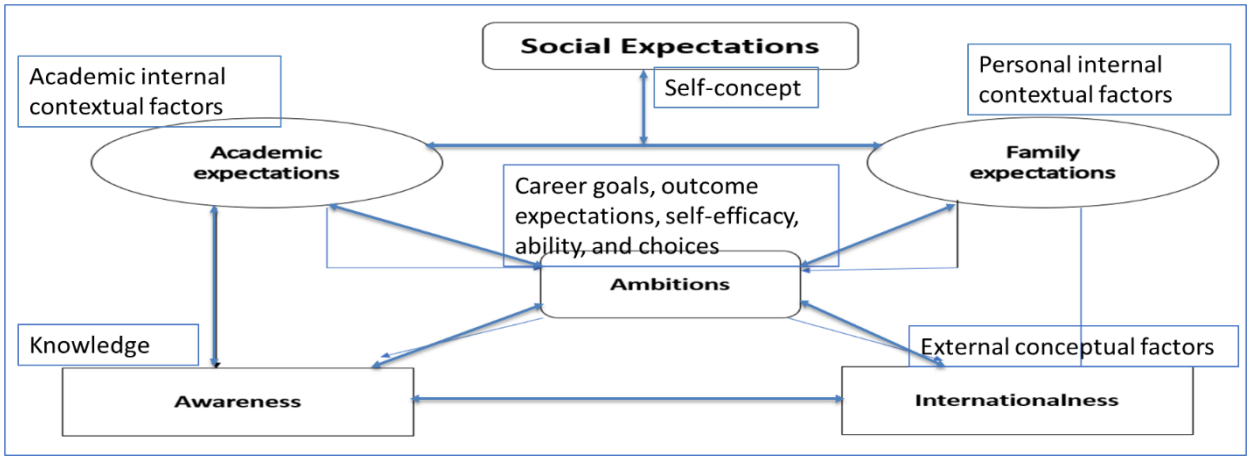


In summary, the emergent theory of social expectation in this study is well married with the five theories above. It is noteworthy that almost all these career development theories acknowledge the active participation of the person (P) in the determination of their career options mostly through self-conceptualization. Self-conceptualization is a complex process of wiring the external contextual factors including state of the economy, labour market structure, hiring practices and family obligations (Leung, p. 124), and internal factors including age, gender, stage in life, and personal preference for prestige (Leung, p. 124). The self-concept of the individual determines their motivation for career options, outcome expectations, self-efficacy perceptions, performance goals, interests and consequent career choices individuals make. Choice making is a process that keeps evolving as the individual gains more knowledge and information about all these factors (Leung, p. 125).

Concluding on the relationship between these career development theories as a wholistic unit viewed alongside the emergent theory of social expectation in this study can be presented as follows (See Figure 20 below for visual illustration):

> *The international STEM PhD student (P) derives their self-concept from a process of social expectations devolution by aggregating their familial expectations (personal internal context factors) and academic expectations (academic internal contextual factors) to determine their ambitions (goals, choices, efficacy, desire, and ability) based on their awareness (knowledge) and internationalness (external contextual factors).*

Figure 22 – Aggregation of career development theories with emergent social expectation theory



Social expectations are an equivalent of the international students' self-concept which is formed as an amalgamation of academic internal contextual factors (academic expectations), and personal internal contextual factors (familial expectations). The extent of student's awareness and knowledge is fused with external conceptual factors and contexts, and the social expectations. This forms the students' eventual ambition.

Limitations of the Study

According to Charmaz (2006, p 46), in the use of grounded theory "We want to know what is happening in the setting, in people's lives, and in lines of our recorded data." This statement indicates the primary limitations of this study which was conducted in virtual meeting rooms, and the dependence on technology in the conduct of interviews. Observation of the settings and how participants chose and interacted within their setting was limited. A lot of these methodological limitations are already discussed in chapter three under methodology. Limitations to the study itself predicated from setting the study within the international STEM and applied sciences PhD student community of the university of Alberta, presenting a small sample population size, this generated a very small sample population of eight participants.

Probably owing to the COVID-19 pandemic and the resulting tensions international students generally faced, the second major limitation is the number of participants in the study. The study was designed to have a minimum of twelve participants, but only nine students responded, with eight participating in the study. This also affected the extent of saturation of the main theoretical model of the study. While a certain level of saturation was attained, the areas of saturation were less than what might have been with the available data. A final limitation of the study is the unlikelihood of generalizability of the study outcome owing to the small sample size, and containment within a subsection of the university of Alberta's international student population.

Suggestions for Further Studies

The conduct of this study did answer the research questions while exposing some other gaps in research that could have been explored. The small size of the study also created a need to conduct a similar study for a larger participant group and across different universities across Canada, as well as across international borders and regions. Such a study will enable ease of

achieving saturation and provide generalizable outcomes. In addition, a study to articulate how interested international students can participate in entrepreneurship, patenting, and innovation, identifying the perceived barriers, and establishing mitigants to the barriers is required. At the university of Alberta there are established systemic lines to foster entrepreneurship and innovation within the STEM and applied science study fields, however participants in this study mostly expressed complete lack of awareness, or their awareness was based on assumptions. A university level study that measures the effectiveness of information and communication of the university's resources to students, especially international students, is valid as the proportion of international student to Canadians is rising. Instituting a study within the university of Alberta to understand how supervisor's career proclivities and student engagement choices are managed to ensure adequate student exposure to patenting, innovation, and entrepreneurial career options, and aid the entrepreneurial university agenda is deemed worthy of consideration.

At the government policy level, many of our participants had a notion of inability to consider entrepreneurship in their postgraduation career thoughts because of barriers to funding, access to information about government taxation and business policies, and most importantly the effect of attempting entrepreneurship on their study permits and the process of transitioning to PR holders. A study that identifies how to create 'visible' specific policy shifts to incorporate entrepreneurially minded and innovative international STEM and applied sciences students in Canada using the Western European models, provincially and at the federal level.

Recommendation from the study

This study was aimed at finding out the impact of the research laboratory culture on international STEM PhD students' postgraduation career choices. It also sought to identify how the research laboratory culture aids the growth of the entrepreneurial university agenda among

international STEM PhD students. The findings indicate there is need for greater traction at the university of Alberta towards guiding students towards possible entrepreneurial postgraduation career options. Firstly, majority of participants indicated they had no knowledge about entrepreneurial career support for students at the university of Alberta. Some others had the idea about the possibility for students to become entrepreneurial but considered the option as available only to Canadian residents. Additionally, several participants joined their research laboratories and fit into ongoing university-industry collaboration projects whose origins they did not know. Participants also indicated being unaware of Canadian legal requirements for entrepreneurial international students especially with respect to their legal status in the country. Borrowing from the participants voices in the study, the following suggestions are specific to the university of Alberta STEM and applied sciences to adjust the visibility of all postgraduation career options for students.

Inculcating Entrepreneurship Career Opportunity into the STEM PhD Programs

Historically, students in PhD programs are assumed to aim for academic careers, however, recent development in academia has shown the diversity of aspirations among PhD students. This was reified by some participants who indicated they had entrepreneurial ambitions but saw a need to work to obtain their PR before attempting to go entrepreneurial. It seems necessary therefore that the entrepreneurial university creates a structure to harness university students who are interested in entrepreneurship, educating them towards what is necessary to become successful entrepreneurs and handholding them as they embark on the process. The recommendation is that the school creates streams within the STEM PhD program for students who would be interested in patenting and innovation or establishing entrepreneurial purposes for existing knowledge.

- This stream should allow the use of patents and or innovation in lieu of publications as criteria for graduation;
- Coursework in the entrepreneurial stream should expose students to different aspects of entrepreneurship;
- Students should be given the opportunity during the entrepreneurial coursework to work alongside and learn from entrepreneurial alumni of the university, especially those from same faculty for firsthand engagement in running a business;
- The entrepreneurial courses should be designed as electives for academic minded students because this study showed that some students inclination to avoid entrepreneurship is due to lack of exposure; and
- Students should have the opportunity to migrate between the entrepreneurial and academic streams by end of their second year in the PhD program.

Following this recommendation creates opportunities for all PhD students in the STEM disciplines to access entrepreneurship education; gives them the opportunity to determine whether or not they wish to pursue entrepreneurship as an educated decision; and they have the flexibility to reconsider their initial choices after two years, so they have a degree of career flexibility as they proceed with their study.

Entrepreneurial Career Information Dissemination

It has become a standard for the university to offer international students orientation seminars at various levels of the university system upon arrival aimed at easing their settlement into the Canadian academic environment. However, as noted by participant, the orientation programmes teach how to be Canadian, and how to meet graduation requirements, but no information is given at whole school, faculty, or departmental orientation to guide international

students towards career thoughts. This creates a knowledge gap for international students as they socialize within the Canadian workforce, thus limiting their knowledge to their exposure within their laboratory experiences. This study recommends the following:

- Systematic integration of all possible career expectations into the onboarding seminars particularly for international students at all levels of the university;
- Continuous knowledge and information iteration through existing internal information dissemination platforms such as departmental, faculty, and student association platforms;
- Inclusion of the route to entrepreneurship, patenting, and how to access and use the Technology Transfer Office, eHUB, and other possible career trajectories into mandatory professional development programs;
- Creating an annual platform for students, especially international students, to interact with alumni of the university who have established businesses and ventures.

REFERENCES

Adu, P. (2017). Using Grounded Theory Approach: From Start to Finish [Video]. Youtube. https://youtu.be/7awjNYdoS6w

Anandavalli, S. (2021). Strengths-based Counseling with International Students of Color: A Community Cultural Wealth Approach. *Journal of Asia Pacific Counseling*, 11, 111-124. http://dx.doi.org/10.18401/2021.11.1.7

Anderson, T. (2017). The doctoral gaze: Foreign PhD students' internal and external academic discourse socialization. *Journal of Linguistics and Education, 37*, 1–10. http://dx.doi.org/10.1016/j.linged.2016.12.001

Anderson, K. L., & Mounts, N. S., (2012). Searching for the Self: An Identity Control Theory Approach to Triggers of Occupational Exploration. *The Journal of Genetic Psychology, 173(1)*, 90-111. http://doi.org/10.1080/00221325.2011.573027

Avenido, K. (2023). An Intersectional Analysis of Chinese International Students' Experiences in Postsecondary Institutions in British Columbia. *Journal of International Students, 13(*1), 22-39.

Baker, V. L., & Pifer, M. J. (2011). The role of relationships in the transition from doctoral students to independent scholar. *Studies in Continuing Education, 33*(1), 5-17.

Bergmanna, H., Geissler, M., Hundt, C., & Grave, B. (2018). The climate for entrepreneurship at higher education institutions. *Research Policy, 47*, 700–716. https://doi.org/10.1016/j.respol.2018.01.018

Bercovitz, J., & Feldman, M. (2008). Academic Entrepreneurs: Organizational Change at the Individual Level. *Organization Science, 19*(1), 69-89. https://doi.org/10.1287orsc.1070.0295

Bienskowska, D., & Klofsten, M. (2011). Creating entrepreneurial networks: academic entrepreneurship, mobility and collaboration during PhD education. *Higher Education, 64*, 207-222. http://doi.org/10.1007/s10734-011-9488-x

Bienkowska, D., Klofsten, M., & Rasmussen, E. (2016). PhD Students in the Entrepreneurial University – Perceived Support for Academic Entrepreneurship. *European Journal of Education, 51*(1), 56-72.

Boonsuk, Y., & Fang, Fa., (2022). Perennial Language Learners or Competent Language Users: An Investigation of International Students' Attitudes towards Their Own and Native English Accents. *Regional Language Centre Journal, 53(1), 40 –55.* http://doi.org/10.1177/0033688220926715

Bradbury-Jones, C. (2007). Enhancing rigor in qualitative health research: Exploring subjectivity through Peshkin's I's. *Journal of Advanced Nursing, 59*(3), 290-298. http://doi.org/10.1111/j.1365-2648.2007.04306.x

Bryant, A. (2003, January). A constructive/ist response to Glaser. About Barney G. Glaser: constructivist grounded theory? Published in FQS 3 (3). In *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research* (Vol. 4, No. 1).

Campanella, F., Della Peruta, M.R., & Del Giudice, M. (2013). The Role of Sociocultural Background on the Characteristics and the Financing of Youth Entrepreneurship. An Exploratory Study of University Graduates in Italy. *Journal of Knowledge Economy, 4,* 244–259. https://doi.org/10.1007/s13132-013-0157-4

Cashwel, E. J., (2021). Recruitment and Data Collection in the 21st Century: Implications for Grounded Theory. *Grounded Theory Review: An International Journal*, *20*(2).

Cason, J. (2016). Preparing Future Scholars for Academia and Beyond: A Mixed Method Investigation of Doctoral Students; Preparedness for Multiple Career Paths. A Dissertation Presented in Partial Fulfillment of the Requirements of the Degree of Doctor of Education, Arizona State University. Proquest LLc (10108575)

Charmaz, K. (2000). Grounded Theory: Objectivist and Constructive Methods. In Norman K. Denzin & Yvonna S. Lincoln (Eds.), Handbook of Qualitative Research, (pp. 509-535).

Charmaz, K. (2008)' Grounded Theory as an Emergent Method. In S. N. Hesse-Biber & P. Leavy (Eds), Handbook of Emergent Methods (p.155-172). New York: The Guilford Press.

Clarysse, B., Tartari, V., & Salter, A. (2011). The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. *Research Policy, 40*, 1084-1093. http://doi.org/10.1016.j.respol.2011.05.010

Costa, I. G., & Schoales, C. (2022). Conducting Grounded Theory Studies in Times of Pandemic: Challenges, Benefits, and Practical Strategies. *New Trends in Qualitative Research*, *10*, e561-e561.

Council of Ministers of Education, Canada, (2020). *Trends in STEM and BHASE graduates from public postsecondary institutions across Canadian provinces and territories.* https://www.cmec.ca/Publications/Lists/Publications/Attachments/420/STEM_BHASE_graduates_report_Final_EN.pdf

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.

Dzisah, J., & Etzkowitz, H. (2011). The triple helix of knowledge. In Dzisah, J., & Etzkowitz, H. (Eds.), *The age of knowledge: The dynamics of universities, knowledge and society* (pp. 127-144). Brill.

Dos Santos, L. M., (2019). Experiences and Expectations of International Students at Historically Black Colleges and Universities: An Interpretative Phenomenological Analysis. *Education Science*, 9(189). doi:10.3390/educsci9030189

Engvall, R. P. (2003). Academic Identity: Place, Race, and Gender in Academia. In Pink, W.T., & Noblit, G. (Eds.), *Understanding education and policy series.* Hampton Press Inc.

Elemo, A. S., & Türküm, A. S. (2019). The effects of psychoeducational intervention on the adjustment, coping self-efficacy and psychological distress levels of international students in Turkey. *International Journal of Intercultural Relations*, *70*, 7-18. https://doi.org/10.1016/j.ijintrel.2019.02.003

Elliot, D.L., Baumfield, V., & Reid, K., (2016). Searching for 'a third space': a creative pathway towards international PhD students' academic acculturation, Higher Education Research & Development, 35(6), 1180-1195. https://doi.org/10.1080/07294360.2016.1144575

Elliot, D. L., Baumfield, V., Reid, K., & Makara, K. A. (2016). Hidden treasure: Successful international doctoral students who found and harnessed the hidden curriculum. *Oxford Review of Education*, *42*(6), 733-748.

Etzkowitz, H. (1983). Entrepreneurial Scientists and Entrepreneurial Universities in American Academic Science. *Minerva, 21(2/3),* 198–233. http://www.jstor.org/stable/41820527

Etzkowitz, H. (2003). Innovation in Innovation: The Triple Helix of University-Industry-Government Relations. Social Science Information, 42(3), 293–337. https://doi.org/10.1177/05390184030423002

Etzkowitz, H. & Zhou, C. (2018). The Triple helix: University–Industry–Government Innovation and Entrepreneurship. Routledge, 2nd Edition.

Etzkowitz, H. (2019). Is silicon Valley a global model or unique anomaly?. *Industry & Higher Education, 33*(2), 83-95. http://doi.org/10.1177/0950422218817734

Farias, L., Brodin, H., and Bergström, A. (2023). Supervisors of International Occupational Therapy Students on Clinical Placement: Perceived Tensions and Hidden Expectations. *Scandinavian Journal of Educational Research, 67(2)*, 268–280. https://doi.org/10.1080/00313831.2021.2006304

Feng Teng, M. (2020). A narrative inquiry of identity construction in academic communities of practice: voices from a Chinese doctoral student in Hong Kong. *Pedagogies: An International Journal 2020, 15(1)*, 40–59. https://doi.org/10.1080/1554480X.2019.1673164

Fini, R., Grimaldi, R., & Sobrero, M. (2008). Factors fostering academics to start up new ventures: an assessment of Italian founders' incentives. *Journal of Technology Transfer, 34,* 380-402. http://doi.org /10.1007/s10961-008-9093-z

Gupta S, Jaiswal A, Paramasivam A and Kotecha J (2022). Academic Writing Challenges and Supports: Perspectives of International Doctoral Students and Their Supervisors. Frontiers in Education, 7(891534). http://doi.org/10.3389/feduc.2022.891534

Gibbs, R. G. (2015). A discussion with Prof Kathy Charmaz on Grounded Theory [Video]. Youtube. https://youtu.be/D5AHmHQS6WQ

Giroux, H. A. (2002). Neoliberalism, Corporate Culture, and the Promise of Higher education: The University as a Democratic Public Sphere. *Harvard Education Review, 72*(4), 425-463.

Glaser, B.G., (2007). Constructivist Grounded Theory? *Historical Social Research, Supplement, 19*, 93-105.

Goulding, C., (2002). *Grounded Theory: A Practical Guide for Management, Business and Market Researchers*, SAGE.

Government of Canada: Panel on Research Ethics. (2018). *Tri-Council Policy Statement (TCPS): Ethical Conduct for Research Involving Humans – TCPS 2 (2018).* http://www.pre.ethics.gc.ca/eng/policypolitique/initiatives/tcps2-eptc2/Default/

Henkel, M., (2005). Academic identity and autonomy in a changing policy environment. *Journal of higher education, 49*, 155-176.

Holt, N. L., Tamminen, K. A., Black, D. E., Sehn, Z. L., & Wall, M. P. (2008). Parental Involvement in competitive youth sports settings. *Psychology of Sport and Exercise, 9,* 663-685. *http://doi.org/10.1016/j.psychsport.2007.08.001*

Idevania G. Costa, & Catherine Schoales. (2022). Conducting Grounded Theory Studies in Times of Pandemic: Challenges, Benefits, and Practical Strategies. *New Trends in Qualitative Research*, *10*. https://doi-org.login.ezproxy.library.ualberta.ca/10.36367/ntqr.10.2022.e561

Janssen, S., van Vuuren, M., & de Jong, M.D.T. (2020). Sense making in supervisor-doctoral student relationships: revealing schemas on the fulfilment of basic psychological needs. *Studies in Higher Education*. http://doi.org/10.1080/03075079.2020.1804850

Kanno, Y., & Norton, B. (2003). Imagined Communities and Educational Possibilities: Introduction. *Journal of Language, Identity & Education*, *2*(4), 241–249. https://doi-org.login.ezproxy.library.ualberta.ca/10.1207/S15327701JLIE0204_1

Kenney, M., & Goe, W. R. (2003). The role of social embeddedness in professorial entrepreneurship: a comparison of electrical engineering and computer science at UC Berkeley and Stanford. *Research Policy, 33,* 691-707. http://doi.org/10.1016/j.respol.2003.11.001

Kitagawa, F. (2014). Collaborative Doctoral Programmes: Employer Engagement, Knowledge Mediation and skills for Innovation. *Higher Education Quarterly, 68*(3), 328-347. http://doi.org/10.1111/hequ.12049

Klofsten, M., & Jones-Evans, Dylan. (2000). Comparing Academic Entrepreneurship in Europe - The Case of Sweden and Ireland. *Small Business Economics, 14*, 299-309.

Kong, M.L.F., & Kang, I. H., (2022). Identity and Accents: Do Students Really Want to Speak Like Native Speakers of English?. *Regional Language Centre Journal, 53(3), 505 –518.* http://doi/10.1177/0033688220939246

Lalina, L. (n.d.). Overview of Career Development Theories. https://www.academia.edu/39814799/Overview_of_Career_Development_Theories

Leung, S. L. (2008). The Big Five Career Theories. In J. A. Athanasou & Van Esbroeck (Eds.). *International Handbook of Career Guidance* (pp. 115-132). Springer.

Levin, B. (2008, May). Thinking about knowledge mobilization. In *an invitational symposium sponsored by the Canadian Council on Learning and the Social Sciences and Humanities Research Council of Canada* (pp. 15-18). https://www.sshrc-crsh.gc.ca/about-au_sujet/publications/kmb_-_levindiscussionpaper_-_e.pdf

Mayan, M. J. (2016). *Essentials of qualitative inquiry*. Routledge.

Mayan, O. H. (2019). Understanding Students' Experiences with E-Learning 2.0 in Australian Higher Education: A Grounded Theory Study. *Online Submission*.

Morrison, R., (2015). Pragmatist Epistemology and Jane Addams: Fundamental Concepts for the Social Paradigm of Occupational Therapy; Occupational Therapy International, 23:295-304.

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods*, *1*(2), 1-19. https://doi.org/10.1177%2F160940690200100202

Muscio, A., Quaglione, D., & Ramaciotti, L. (2016). The effects of university rules on spinoff creation: The case of academia in Italy. *Research Policy, 45(7)*, 1386-1396. http://doi.org/10.1016/j.respol.2016.04.0110048-7333

Nagel, D. A., Burns, V. F., Tilley, C., & Aubin, D. (2015). When Novice Researchers Adopt Constructivist Grounded Theory: Navigating Less Travelled Paradigmatic and Methodological Paths in PhD Dissertation Work. *International Journal of Doctoral Studies, 10,* 365-383.

Nelles, J., & Vorley, T. (2009). Constructing an Entrepreneurial Architecture: An Emergent Framework for Studying the Contemporary University Beyond the Entrepreneurial Turn. *Innovations in Higher Education Journal, 35*, 161 – 176. https://doi.org/10.1007/s10755-009-9130-3

Osipow, S. H., & Fitzgerald, L. F., (1996). Theories of career development. 4th Edition. Allyn & Bacon.

Pepanyan, M., Meacham, S. & Logan, S. (2018). International students' alienation in a US higher education institution. *Journal for Multicultural Education, 13(2)*, 122-139.

Perkins, H., Tsugawa-Nieves, M. A., Chestnut, J. N., Miller, B., Kirn, A., & Cass, C. (2017, June). The role of engineering identity in engineering doctoral students' experiences. In *2017 ASEE Annual Conference & Exposition*.

Puddephatt, A. J. (2006). An interview with Kathy Charmaz: On constructing grounded theory. *Qualitative sociology review*, *2*(3).

Poland, B.D. (1995). Transcription quality as an aspect of rigor in qualitative research. *Qualitative Inquiry, 1(3)*, 290-310.

Saldana, S. (2008). An introduction to codes and coding: Chapter 1. *Retrieved from*.Academia,edu.com

Sandelowski, M., & Barroso, J. (2003). Writing the proposal for a qualitative research methodology project. *Qualitative health research*, *13*(6), 781-820. https://doi.org/10.1177/1049732303255474

Smirnova, Y. V. (2014). Knowledge, knowledge transfer, technology transfer: a conceptualization. In *6th International Conference on Building Cultural Bridges: Integrating Languages, Linguistics, Literature, Translation and Journalism into Education, Almaty, Kazakhstan*.

Tartari, Valentina. (2011). The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. *Journal of Research Policy, 40*, 1084-1093. http://doi.org/10.1016/j.respol.2011.05.010

Thune, T. (2009). Doctoral students on the university-industry interface: a review of the literature. *Higher Education Journal, 58*, 637-651. http://doi.org/10.1007/s10734-009-9214-0

Walsh, E., Hargreaves, C., Hillemann-Delaney, Ulrike., & Li, J. (2015). Doctoral researchers' views on entrepreneurship: ranging from 'a responsibility to improve the future' to 'a dirty word'. *Studies In Higher Education, 40*(5), 775-790. http://doi.org/10.1080/03075079.2013.842219

Walsh, L., & Gleeson, J. (2021). Theorising and preparing students for precarity: how can leaders and educators better prepare students to enter an increasingly insecure workforce?. *Journal of Educational Administration and History*, 1-13. http://doi.org/10.1080/00220620.2020.1868981

Young, I. M. (1986). The ideal of community and the politics of difference. Social Theory and Practice, 12(1), 1-26.

APPENDICES

Appendix 1 – Research Ethics Board (R.E.B) Approval letter

Notification of Approval

Date:	March 1, 2022
Study ID:	Pro00117497
Principal Investigator:	Olukemi Olugbade
Study Supervisor:	Kent Rondeau
Study Title:	WAYS TO GO: A grounded theory study of how the laboratory culture in the applied sciences impact on international doctoral students' career paths in the STEM/applied sciences?
Approval Expiry Date:	February 28, 2023
Sponsor/Funding Agency:	EFF Support for the Advancement of Scholarship

Thank you for submitting the above study to the Research Ethics Board 1. Your application has been reviewed and approved on behalf of the committee.

Approved Documents:

Recruitment Materials

Olugbade_Olukemi _REB_1_Consent_letter2.pdf

Questionnaires, Cover Letters, Surveys, Tests, Interview Scripts, etc.

Olugbade_Olukemi_Questionnaire-STUDY OF INTERNATIONAL DOCTORAL STUDENTS 3.docx

Olugbade_Olukemi_Questionnaire_2.pdf

Protocol/Research Proposal

Olugbade_Olukemi - Thesis Proposal.pdf

Any proposed changes to the study must be submitted to the REB for approval prior to implementation. A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit

an ethics application.

Approval by the REB does not constitute authorization to initiate the conduct of this research. The Principal Investigator is responsible for ensuring required approvals from other involved organizations (e.g., Alberta Health Services, Covenant Health, community organizations, school boards) are obtained, before the research begins.

Sincerely,

Carol Bolick, PhD
Associate Chair, Research Ethics Board 1

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Appendix 2 – Sample Confidentiality Agreement

Confidentiality Agreement Sample

This form will be used for individuals who volunteer to participate in the focus group session of the study.

Project title - **WAYS TO GO: A grounded theory study of how the laboratory culture in the applied sciences impact on international doctoral students' career paths in the STEM/applied sciences**

I, _____, am a focus group participant in the above-named study.

I agree to -

1. keep all the research information shared with me confidential by not discussing or sharing the research information in any form or format (e.g., disks, tapes, transcripts) with anyone outside of the focus group session.
2. direct any need to truncate, not respond to specific question or withdraw from study only to Principal Investigator
3. direct all inquiries into the focus group conduct to Principal Investigator via email at olugbade@ualberta.ca or the supervisor at kent.rondeau@ualberta.ca.
4. direct further inquiries about the conduct of the research, I will contact the Research and Ethics Board at the University of Alberta via phone on 780-492-2615.
5. other (specify).

_____	_____	_____
(Print Name)	(Signature)	(Date)

Researcher(s)

OLUGBADE OLUKEMI A.	_____	_____
(Print Name)	(Signature)	(Date)

The plan for this study has been reviewed for its adherence to ethical guidelines and approved by Research Ethics Board *(specify which board)* at the University of Alberta. For questions regarding participant rights and ethical conduct of research, contact the Research Ethics Office via email reoffice@ualberta.ca.

February 19, 2022 Pro00117497

Appendix 3 – List of possible open ended questions

LIST OF POSSIBLE OPEN-ENDED QUESTIONS FOR INTERVIEWS

Study Title:

WAYS TO GO: A grounded theory study of how the laboratory culture in the applied sciences impact on international doctoral students' career paths in the STEM/applied sciences.

Principal Investigator:

Olugbade Olukemi A.,

I.D. 1560037

This study is using Constructivist Grounded Theory (CGT) methodology which emphasizes the use of language as an ontological tool and acknowledges opportunity for participants to co-create data with participants. This methodology allows researchers to iterate interview questions in a bid to get a thorough understanding of the participants responses. Ensuring responses are truly the intentions of participants, CGT interviews are unstructured and use open-ended questions.

Although it is important to ensure participants are given a voice by allowing questions to flow organically, it is vital to have a list of possible questions to guide the interviews. The possibility of research outcomes varying from intended study is a relevant fact. However, to lead towards the intended outcome for this study, the following are some of the expected question leads:-

1) Describe how you found out about your professor?
2) What would you say your greatest reason or motivator is for doing a doctorate and what you hoped to become before you started the program?
3) What factors would you say was predominant in your decision to work with your professor and his research laboratory?
4) In your work life, who or what have been your greatest influencers: could it be colleagues, postdocs, professors, family, etc?
5) Would you say your laboratory has a specific organizational structure? If yes, explain or describe it to us?
6) Comparing your personal values and those of your laboratory, how would you describe the alignment?
7) Could you describe your immediate impression upon arrival/landing in the laboratory, when you met colleagues and got involved in the structures, processes, and organization?
8) How do you plan to get into your choice of career projection from this laboratory experience?

9) In your own words, how would you describe the culture in your laboratory from your personal perspective?
10) Describe the culture towards engagement with industry, government and the community in your laboratory
11) Speaking from the perspective of other members of your laboratory, what will you say is the main driver for engagement in your laboratory?
12) Could you say your contextual background affected or was affected by your journey/process of socializing with your colleagues?
13) Would you describe the impact of your supervisor and his/her reputation on your progress or process of determining your post-doctoral career?

Appendix 4 – Sample memo about formation of Conceptual codes

Working the Triple Helix	1	Experience	What students experience or hope to experience when they engage with the various sectors of the triple helix is formative. They experience what they are exposed to, what they are exposed to within their labs for the roots of their perceptions and often they have no means of checking whether or not these perceptions are right. These experiences become a form of 'conditioning' of students' minds. The

Adjusting to Canadian environment			degree and specifics of engagement creates a mental map for their own expectations beyond which they are unlikely to attempt. Although these exposures do not determine they will fully extent themselves within the perceived scope, it means they may become inured to possibilities outside this pre-set scope. These experiences cordon off their expectations towards future career possibilities. There is a process that sort of 'others' and excludes options for students such that unless they have equally experienced other possibilities, personally or through the knowledge of others who have, they are unaware. The exclusion is a reason why many are unaware of the university's TTO and entrepreneurial resources - their labs do not indulge in such; they have no need to access the resources even if they were aware. This is why experiences denote expectations in my mind. As international students, their experiences from their laboratory’s socialization efforts forms their network of prospects, whether as mentors, employers or colleagues. Hearing some participants unable to connect how their work could relate with government, no knowledge of processes, or

			opportunity for entrepreneurship all portend a gap in STEM and Applied sciences students' exposure to the third mission in an entrepreneurial university such as the UofA.
University aiding students	2	Career thoughts	By reason of their description as 'international students' it is expected that these students, in whatever course they may be in, they must cross the "outsider-insider" barrier in settling into their new academic and social communities. The efforts to enable this is facilitated by assistance from several hierarchies of power, representing different agencies

Thinking career trajectories			outside the school, and the within. The extent of information made available by these layers of administration can be considered "technically unavailable" to the extent that students are unaware or do not access it. From the data gathered, students are not accessing information towards entrepreneurial training, patenting and innovation at the university, faculty, departmental or lab levels. Some students mentioned interest in entrepreneurship but are defaulting to industry or government because of this. Other students signify possible interest with access to the right support and information. Lack of information about the Canadian legal requirements concerning entrepreneurship, innovations, and patenting processes for international students. This internationalization creates a sense of finality for these students. Then the lack of information and apparent seclusion from these options creates a mental barrier when thinking career thoughts. A further internationalization of the PhD experience is the segregation between international and resident/local students career thoughts which occurs because of finances and
Internationalizing the PhD Experience			
Feeling about PhD decision			

			immigration issues, on their PhD journey. Some students might be able to cross over this barrier depending on intersectionalities such as stage of life, gender, language and accented-ness, cultural background, circumstances of leaving their home country, and other personal contexts including personality differences. Generally, international students who graduate without PR are limited to industry or academia owing to immigration restrictions and financial constraints. Because they are aware of this, those who might have been interested in other career opportunities constrain themselves to what they consider as available options: industry or academia. How individual students perceive the importance and value of their PhD experience makes them feel either adequate or inadequate for certain sectors and not others. Overall, international STEM PhD students decode career opportunities differently from their Canadian contemporaries given the same issues based on how they are feeling about the program, their intersectionalities and the perceptions of university's assistance. Maybe the career thoughts of international students in STEM

			will be expanded with more concerted strategies aimed directly at graduate students, and programmes that give more visibility to the schools' entrepreneurial agenda.
Reflecting on COVID 19 pandemic Reflecting on self context Tapping student agency	3	Students' intersectionality	The COVID -19 pandemic experience was a point of reference for international students mostly resulting from the differential treatment they received relative to PR or Canadian students. Reflections on how they dealt with the pandemic and what they and others experienced left an indelible mark on the students' minds, which is being carried into their expectations and perceptions about rights, privileges, and opportunities for them in Canada as they complete their studies. The personal contexts of each student defined their intersectionalities and some of the factors included gender, personal and cultural values, and pre-PhD lived experiences. Another relevant factor international STEM PhD students are thinking about their post-PhD careers, it seems a strong value they seldom mention is their

			family/marital situation. The laws 'internationalizes' spouses and partners of international students as significantly as it affects the students too. Similarly, students' ability to deploy personal agency leads to differences in accomplishment. Variations in how students deploy their personal agency is an additional intersectionality.
Supervisor has impact on career path	4	Supervisor impact	The supervisor is the CEO of the laboratory. The laboratory leadership, culture and structure they establish in the laboratory directly impacts the students. Supervisors socialize students into the communities of practice in academia, industry and government, helping student build upon their network. Supervisor's neglect of engagement with any aspect of the triple helix steer students away from those areas for career choices. Supervisor's mentorship and guidance directly feeds into students' career choices.
Laboratory culture			

Appendix 5 – Summary table of Doctoral students study respondents

Timestamp	Descriptor	PhD Study year	Gender	Age:	Department of study	Geographical region of origin	How many years of graduate education did you have before your PhD?	First language	Was any part of your prior studies in English language?	How many years of your prior study was english?	Is your Doctoral program your first degree outside your home country?	Did you know your supervisor before your application into your program?	How did you find out about your supervisor?	Did you have prior contact with your supervisor before your program?	Did you ever visit Canada before the onset of your course?	Approximate time in Canada before the start of your program?	Did you travel with spouse/partner/family?	Did you arrive at the same time with your spouse/partner/family?	Do you have your child(ren) with you in Canada?	If yes, child(ren) age range?	Do you have child-care/child-support/family-support?	Are you comfortable having a one-on-one interview via zoom?	Are you comfortable with being allotted a unique identity to use for login into the interview sessions?	Are you comfortable having the interview session recorded? (All recordings will be used for transcription purposes after which it will be encrypted for storage)
3/18/2022 10:46:34	P1	6	Female	31 - 40	Chemical and Materials Engineering	South American	2	Spanish	Yes	2	No	Yes	I did my MSc under his supervision	No	Yes	2 years	Not Applicable	Not Applicable	Not Applicable		Not Applicable	Maybe	Yes	Maybe
3/27/2022 19:32:43	P2-EEE	3	Male	20 - 30	EEE	South Asian	2	Malayalam	Yes	6	Yes	No	Website	No	No	0	No	No	No		No	Yes	Yes	Yes
4/4/2022 20:43:16	P3-BSC	3	Female	31 - 40	BSC	Eastern European	4	Serbian	Yes	2	No	No	Web page	Yes	No	2 weeks	Yes	No	Yes	0 - 2 years	Yes	Yes	Yes	Yes
4/5/2022 20:15:29	P4-CME	4	Female	20 - 30	CME	South East Asia	0	Hindi	Yes, entirely in english	16	Yes	No	She contacted me through email	No	No	1 month	No	Not Applicable	No		Not Applicable	Yes	Yes	Yes
4/12/2022 11:10:48	P5-BSC	3	Male	31 - 40	BSC	South-America	0	Portuguese	No	NA	No	No	University website	Yes	No	1 month	Yes	Yes	No		Not Applicable	Maybe	Maybe	Maybe
4/29/2022 18:56:11	P6-CHE	3	Female	20 - 30	Chemistry	East asian	2	Mandarin	Yes	2	No	Yes	School website	Yes	No	3 days	No	Not Applicable	Not Applicable		Not Applicable	Yes	Yes	Yes
5/4/2022 11:22:13	P7-MCE	4	Female	31 - 40	MCE	South America	2	Spanish	No	0	No	No	University website	Yes	No	0	No	Not Applicable	No		No	Yes	Yes	Yes
5/4/2022 20:27:01	P8-MCE	3	Male	31 - 40	MCE	West African	2.5	English	Yes	8	No	No	School website and recommendation	Yes	No	0	Not Applicable	Not Applicable	Not Applicable		Not Applicable	Yes	Yes	Yes
5/11/2022 14:47:03	P9	4	Male	20 - 30	Agriculture, Food, and Nutritional Science	South-America	2	Spanish	No	N/A	Yes	No	School website	No	Yes	1 month	No	Not Applicable	No		Not Applicable	Yes	Yes	Yes
5/29/2022 21:49:49	P10	5	Male	31 - 40	Engineering	North America	5	Spanish	No	0	No	No	University Website	No	No	0 days	Yes	No	Yes	3 - 5 years	Yes	Yes	Yes	Yes