

University of Windsor

## Scholarship at UWindor

---

Electronic Theses and Dissertations

Theses, Dissertations, and Major Papers

---

2016

# The Relationship between Mindset and Self-efficacy in Pre-service Elementary Teacher Candidates Teaching Science, and its Implications on Science Teaching

Stephanie Deanna Palazzolo  
*University of Windsor*

Follow this and additional works at: <https://scholar.uwindsor.ca/etd>

---

### Recommended Citation

Palazzolo, Stephanie Deanna, "The Relationship between Mindset and Self-efficacy in Pre-service Elementary Teacher Candidates Teaching Science, and its Implications on Science Teaching" (2016). *Electronic Theses and Dissertations*. 5755.  
<https://scholar.uwindsor.ca/etd/5755>

This online database contains the full-text of PhD dissertations and Masters' theses of University of Windsor students from 1954 forward. These documents are made available for personal study and research purposes only, in accordance with the Canadian Copyright Act and the Creative Commons license—CC BY-NC-ND (Attribution, Non-Commercial, No Derivative Works). Under this license, works must always be attributed to the copyright holder (original author), cannot be used for any commercial purposes, and may not be altered. Any other use would require the permission of the copyright holder. Students may inquire about withdrawing their dissertation and/or thesis from this database. For additional inquiries, please contact the repository administrator via email ([scholarship@uwindsor.ca](mailto:scholarship@uwindsor.ca)) or by telephone at 519-253-3000ext. 3208.

**The Relationship between Mindset and Self-efficacy in Pre-service Elementary  
Teacher Candidates Teaching Science, and its Implications on Science Teaching**

By

**Stephanie Palazzolo**

A Thesis  
Submitted to the Faculty of Graduate Studies  
through the Faculty of **Education**  
in Partial Fulfillment of the Requirements for  
the Degree of **Master of Education**  
at the University of Windsor

Windsor, Ontario, Canada

2016

© 2016 Stephanie Palazzolo

**The Relationship between Mindset and Self-efficacy in Pre-service Elementary  
Teacher Candidates Teaching Science, and its Implications on Science Teaching**

by

**Stephanie Palazzolo**

APPROVED BY:

---

Dr. Pierre Boulos  
Department of Philosophy & Centre for Teaching and Learning

---

Dr. Darren Stanley  
Faculty of Education

---

Dr. Geri Salinitri, Advisor  
Faculty of Education

Tuesday, May 17<sup>th</sup>, 2016

## DECLARATION OF ORIGINALITY

I hereby certify that I am the sole author of this thesis and that no part of this thesis has been published or submitted for publication.

I certify that, to the best of my knowledge, my thesis does not infringe upon anyone's copyright nor violate any proprietary rights and that any ideas, techniques, quotations, or any other material from the work of other people included in my thesis, published or otherwise, are fully acknowledged in accordance with the standard referencing practices. Furthermore, to the extent that I have included copyrighted material that surpasses the bounds of fair dealing within the meaning of the Canada Copyright Act, I certify that I have obtained a written permission from the copyright owner(s) to include such material(s) in my thesis and have included copies of such copyright clearances to my appendix.

I declare that this is a true copy of my thesis, including any final revisions, as approved by my thesis committee and the Graduate Studies office, and that this thesis has not been submitted for a higher degree to any other University or Institution.

## ABSTRACT

Bandura's (1997) theory of self-efficacy and Dweck's (1999) implicit theories of intelligence (also known as "self-theory" and latter referred to as "mindset"), are explored in the context of pre-service elementary teachers teaching science. Many difficulties elementary pre-service teachers experience in teaching science interfere with student performance. In this study, literature reviews self-efficacy and self-theory individually and together as a means to explain the teacher-student performance relationship. Surveys were distributed to elementary pre-service teachers at the University of Windsor, and results suggest a significant positive relationship between high self-efficacy in science and a growth mindset. The study determined that the first year of University of Windsor's B.Ed program does not influence mindset nor self-efficacy in science teaching. These findings are important in understanding teaching behaviours when teaching science.

## DEDICATION

*I would like to dedicate my M.Ed Thesis to all of the amazing teachers in my life.*

## ACKNOWLEDGEMENTS

I would like to acknowledge one of the most empowering woman that I have the pleasure of knowing: Dr. Geri Salinitri. From supporting my educational endeavours in Sciences to encouraging my lifetime career in teaching, you have been an incredible role model throughout my education. I am so grateful for the countless hours you've spent understanding, supporting, and providing knowledgeable, constructive feedback to my project. My grand, far-fetched ideas at the beginning of my studies are, bit by bit, seeming a little less far-fetched. Your motivation, persistence, and passion for teaching and learning inspires me to become a great leader in education. Thank-you for believing in me, pushing me beyond my comfort zones, and mentoring me throughout my educational journey. Without your guidance, this thesis would not have been possible.

I would like to thank my committee members, Dr. Darren Stanley and Dr. Pierre Boulos for their engagement in my studies and for their support in my development as scholar in Education. I value your insightful feedback, and I appreciate your time in shaping me as a researcher.

I want to extend thanks to Dan Edelstein and Kristi Thompson for helping facilitate the statistical analyses in my study. And I would also like to thank Dr. Clara Howitt and Fouada Hamzeh.

Clara, you are a staple figure in the development of my Thesis. Thank-you for introducing me to Carol Dweck's Mindset concept. From your Leadership in Education

class, it was evident that our intellectual discussions surrounding leadership went far beyond simply the hierarchical constructs of administration. The moment you mentioned Mindset in students, I was excited to delve deeper and look at Mindset in teachers. You empowered me to hypothesize connections in self-efficacy and to address gaps in Mindset research. I cherish your teachings and I will continue to be inspired by your leadership techniques.

Fouada, you have taught me too many things to count! From grade eleven Biology and Chemistry to Lesson Study in Education, you are still empowering me to learn. Your passion for education is compelling and infectious. I would have no interest, nor career in Science or Education if it wasn't for you. Thank-you for your wise advice and friendship. You have had a large impact on my life and I am so grateful to know you.

Last, I would like to give a special thanks to all of the pre-service teacher candidate participants. This document would not exist without your involvement.



## TABLE OF CONTENTS

DECLARATION OF ORIGINALITY .....	iii
ABSTRACT .....	iv
DEDICATION .....	v
ACKNOWLEDGEMENTS .....	vi
LIST OF TABLES.....	xi
LIST OF FIGURES .....	xii
LIST OF APPENDICES.....	xiii
LIST OF ABBREVIATIONS .....	xiv
CHAPTER 1: INTRODUCTION.....	1
Background of Study.....	2
Student Performance in Science and Problem-Solving .....	3
Teacher Performance and Student Success.....	7
Statement of Problem.....	11
Overview of Study .....	15
Purpose of the Study.....	15
Research Questions and Hypotheses .....	15
Rationale.....	17
CHAPTER 2: REVIEW OF THE LITERATURE.....	19
Theories of Academic Motivation & Achievement .....	19
Drive Theory.....	20
Attribution Theory.....	20
Social Cognitive Theory .....	21
Theory of Self-Efficacy .....	22
Achievement Goal Theory.....	25
Social Cognitive Theory of Motivation.....	25
Mindsets .....	26
Model Depicting Relationship between Self-Theories and Self-Efficacy .....	29
Instrumentation .....	30

History of Instruments to Measure Self-Efficacy.....	30
History of Instruments to Measure Mindset .....	34
Studies of Self-Efficacy in Teaching Science.....	38
Self-Efficacy in Teachers .....	38
Improving Self-Efficacy in Teachers .....	41
Studies of Mindset .....	49
Improving the Mindset of Students .....	49
Physiology of a Brain Exhibiting a Growth Mindset .....	51
Mindset in Adults in Education.....	52
Studies of Mindset and Self-Efficacy.....	54
Discrepancies in Elementary Teacher Mindset and Science-Teaching Self-Efficacy.....	56
Conclusion.....	57
<b>CHAPTER 3: METHODOLOGY.....</b>	<b>58</b>
Study .....	58
Purpose & Research Questions .....	58
Research Design.....	59
Participants and Setting .....	60
Instrumentation .....	63
Measuring Self-Efficacy using the STEBI-B.....	64
Measuring Mindset using the General ITIS .....	67
Demographics .....	68
Reliability of SEMSurvey.....	68
Questionnaire.....	69
Ethical Considerations.....	69
<b>CHAPTER 4: DATA COLLECTION &amp; ANALYSIS .....</b>	<b>70</b>
Introduction .....	70
Data Collection .....	71
SEMSurvey.....	71
SEMQuestionnaire .....	74
Data Analysis.....	76
Analysis of Quantitative Data .....	77
Analysis of Qualitative Data.....	82

CHAPTER 5: DISCUSSION .....	88
Interpreting Quantitative Results .....	88
Interpreting Qualitative Results .....	93
CHAPTER 6: CONCLUSION .....	96
Study Summary.....	96
Findings and Implications .....	97
Limitations.....	98
Recommendations for Further Studies .....	100
REFERENCES .....	102
APPENDICES.....	120
Appendix A. Letter of permission to use elementary teacher candidate emails. ....	120
Appendix B. Letter of Information for Consent to Participate in Research .....	121
Appendix C. Original STEBI-B.....	123
Appendix D. General ITIS.....	125
Appendix E. Self-Efficacy and Mindset Survey .....	126
Appendix F. Self-Efficacy and Mindset Questionnaire.....	129
VITA AUCTORIS .....	130

## LIST OF TABLES

Table 1. Research Questions, Data Sources, and Data Analysis.....	70
Table 2. Elementary Pre-service Teachers' SEMSurvey Item Means.....	71
Table 3. SEMQuestionnaire Responses.....	74
Table 4. Paired SEMSurvey Scores.....	77
Table 5. Normality of Self-Efficacy and Mindset Paired Data from SEMSurvey.....	80
Table 6. Correlation of Mindset and Self-Efficacy.....	81
Table 7. Comparison of Mean Scores from Pre- and Post-SEMSurvey.....	82
Table 8. Alternate Variables and their effects on Self-Efficacy and Mindset in Teaching Science.....	86

## LIST OF FIGURES

Figure 1. Connection between Self-efficacy, Teaching Science Effectively (Blase & Greenfield, 1980), and Student Performance in Science (Mohamadi & Asadzadeh, 2012; Pan, 2014).....	13
Figure 2. Summary of the Development of Theories.....	29
Figure 3. Relationship between Self-efficacy and Mindset (Bandura & Wood, 1989)....	30
Figure 4. Normality Distributions of Paired Data from SEMSurvey.....	79

## LIST OF APPENDICES

Appendix A. Letter of Permission to use Elementary Teacher Candidate Emails.....	120
Appendix B. Letter of Information for Consent to Participate in Research.....	121
Appendix C. Original STEBI-B.....	123
Appendix D. General IT IS.....	125
Appendix E. Self-Efficacy and Mindset Survey.....	126
Appendix F. Self-Efficacy and Mindset Questionnaire.....	129

## LIST OF ABBREVIATIONS

FM - Fixed Mindset

GM - Growth Mindset

ITIS - Implicit Theories of Intelligence Scale

J/I - Junior/Intermediate divisions of the University of Windsor's Bachelor of Education program. This division covers teaching students in grades 4 to 10.

M - Mean

OECD - Organization for Economic Cooperation and Development

PD - Professional Development

PISA - Programme for International Student Assessment (PISA), promoted by the Organization for Economic Cooperation and Development, is an international test that assesses 15-year-old students in reading, mathematics, science and problem-solving.

P/J - Primary/Junior division of the University of Windsor's Bachelor of Education program. This division covers teaching students in Junior Kindergarten to grade 6.

PSTE - Personal Science Teaching Efficacy

$r_s$  - Spearman's Rho correlation coefficient

$r_s$  - Pearson correlation coefficient

SCT - Social Cognitive Theory

SD - Standard Deviation

SEM - Self-Efficacy and Mindset

SPSS - Statistical Package for Social Sciences

STEBI - Science Teaching Efficacy Belief Instrument

STOE - Science Teaching Outcome Expectancy

TIMSS - Trends in International Mathematics and Science Study

TPA - Teacher Performance Appraisal

## CHAPTER 1: INTRODUCTION

In our rapidly evolving, technology-based world, there is growing need for science and technology in the society and environment. The younger generation is our future, but much of the responsibility of shaping our future in the society and environment relies on science educators. The achievement gap between high performing students and low performing students, is largely influenced by their teachers; therefore there must also be a gap between high performing and low performing teachers (Siedel & Shavelson, 2007). Since teachers are the stakeholders in student education, it comes as no surprise that the Ministry of Education of Ontario have student improvement initiatives based mainly on teacher development in all subjects (Ministry of Education, 2013). This study is specific to elementary pre-service teachers teaching science. It explores self-efficacy and mindset (used interchangeably with “implicit theories of intelligence,” and “self-theories”) as two of the main factors in predicting teacher performance. It was widely believed that a strong content background in science relates to a higher level of teacher self-efficacy (Pajares, 2005; Posnanski, 2002; Shrigley & Johnson, 1974), but little research in mindset is prevalent to teachers. Henson (2001) indicates that teacher efficacy is malleable, specifically through mastery experiences, where much of the research in self-efficacy focuses. Self-efficacy and mindset theories are thought to be closely related (Bandura & Wood, 1989) but few studies provide evidence to support this. This study analyzes the self-efficacy and mindset in a group of elementary pre-service teacher candidates from the University of Windsor.



### *Background of Study*

Recently, there has been concern regarding the difficulties that elementary school teachers experience in teaching science and how their performance can be improved. The majority of literature found focuses on studies of teachers' fixed characteristics (degree earned, years of experience, etc.) as a means to explain the concern (Giddings, 2005; Howitt, 2007; Nenneman, 1971). Little research provides a consolidated understanding of the malleable characteristics of teachers, such as beliefs.

Self-efficacy and mindset are theories based on intrinsic beliefs (Bandura, 1995). According to Bandura, teacher self-efficacy is the teacher's belief about their ability to teach and meet their desired outcomes for their students. One can develop self-efficacy through four modes of perceived self-efficacy: mastering subjects or experiences, attaining an experience vicariously through another person, being verbally persuaded that one can master tasks, or being physiologically unaffected by negative beliefs about succeeding in a task (Bandura, 1997). Research suggests that self-efficacy influences teacher performance, especially for elementary teachers (Buss, 2010; Butts, 1988; Oliver 1995; Riggs, 1995). Elementary school teachers are required to teach all subjects in the school system; however, they are not masters of all subjects they teach and their performance may reflect this. Self-efficacy offers an explanation for low teaching performance (Bandura, 1997); however, it is partial because not every teacher's performance is based on their ability to reach a mastery level. Bandura and Wood (1989) proposed a model to complete this puzzle, connecting self-efficacy to a theory known as the *Implicit Theory of Intelligence* (also referred to as "self-theories" or later termed "mindset").

Mindset is one's beliefs about one's own intelligence and how one can alter one's achievements through motivation to influence one's success (Blackwell, Trzesniewski, & Dweck, 2007; Dweck, 1986). Those possessing a Growth Mindset (GM), also called "incremental intelligence," believe that through effort they can surpass their level of intelligence, and those possessing a Fixed Mindset (FM), also called "entity theory of intelligence," believe that they are born with a certain amount of intelligence. Although there is research on mindset in students (Blackwell et al., 2007; Duckworth & Quinn, 2009; Saunders, 2013), research is lacking to support the suggestion that mindset influences teacher performance. Furthermore, few support Bandura and Wood's (1989) model suggesting that a high level of self-efficacy is connected to an incremental theory of intelligence and that a low level of self-efficacy is connected to a fixed theory of intelligence.

This study examines the two theories in the context of pre-service elementary teacher candidates' teaching science, addresses the gap in teacher performance by testing Bandura and Wood's (1989) model, and investigates the relationship between teacher mindset and self-efficacy. The outcome of this study helps highlight the problems elementary teachers face when teaching science and provides insight into how these problems may be solved to help improve student performance.

### ***Student Performance in Science and Problem-Solving***

The elementary years of a student's life are especially important in education (Riles, 1973). During this period, students' minds are fresh and more malleable than in secondary school and adulthood (McClelland & Siegler, 2001), and their beliefs and attitudes are at their most influential state (Erikson, 1994). Through elementary

education, teachers help shape their student beliefs and attitudes towards science and other subjects.

A program called Trends in International Mathematics and Science Study (TIMSS) assesses elementary student performance internationally. The average Canadian Grade 4 science achievement scores dropped from 540 (2003) to 528 (TIMSS, 2011). Where Canadian scores were dropping, other countries, such as the United States, were increasing. U.S. Grade 4 Science achievement scores have increased to 544 (TIMSS, 2011). This shows that Canadian students are lacking something in science education.

The Programme for International Student Assessment (PISA), promoted by the Organization for Economic Cooperation and Development (OECD), is an international test that assesses 15-year-old students in reading, mathematics, science, and problem-solving. These data from this study provide an idea of how elementary education and the first year of secondary education influence cognitive development over time. PISA (2014) assessment results provide insight into the performance of students, which is a direct reflection on the performance of teachers.

Focusing on the most recent PISA science results from 2012 (OECD, PISA, 2014), from the 65 country participants and 28 million student-participants, Shanghai, Hong Kong, Singapore, Japan, and Finland were the top five performers in science. Canada falls in the top 20 performers above the OECD average, placing 8<sup>th</sup> in science. Across all countries, only 8% of students are top performers in science, possessing the ability to explain and apply scientific knowledge to real life situations.

Learning science is largely based on and involves the experimental/scientific method (Matheson, 2014), whereby a problem is identified, hypotheses are generated,

procedures are developed to test those hypotheses, data is collected and analyzed, results are discussed or explained, and, finally, a conclusion is drawn from the study. Science is not only important to those studying it: everyday problems can be solved using the scientific method. The scientific method provides an important framework that is applicable to all subjects that value problem-solving (Fulton & Sabatino, 2008; Gerde, Schachter & Wasik, 2013). The process of problem-solving incorporates many aspects similar to the scientific method: A problem is identified, methodology of solving the problem is brainstormed and executed, results are summarized, and a conclusion is drawn. PISA identifies teachers' influence student problem-solving skills through encouraging metacognitive reflection on students' solution strategies. Teachers initiate student use of metacognition by asking students to describe their steps to the solution, and reflect on the effectiveness, and consider how they could improve it (OECD, PISA, 2014). The reflection process can expand students' repertoire of principles that can be applied to different situations or subjects, including science. This process of metacognition is similar to the scientific method where students are faced with a situation that requires hypothesizing and utilizing inquiry-based experimentation to propose an explanation or solution to the problem (Gerde et al., 2013).

Reviewing the PISA (2014) results of problem-solving, students in Singapore, Korea, and Japan score the highest in problem-solving. Canada falls above the average OECD problem-solving average, taking 8<sup>th</sup> place. Across all countries, only 11.4% of students are top performers in problem-solving, possessing a level 5 or 6 score, which means that they have the ability to explore a complex scenario, devise solutions, and adjust accordingly. The top three countries in problem-solving have more than one in five

students achieving a level 5 or 6 in problem-solving, whereas all other countries have significantly less than one in five students achieving a level 2. Students achieving a level 2 are only able to solve very simple problems that don't require thinking ahead. This information is important because it quantitatively shows us the quality of students' problem-solving abilities, which is an indirect reflection of the teachers' performances.

Although Canada's 15-year-old students' results in science and problem-solving are above OECD averages, the worldwide results indicate otherwise low problem-solving and science results. What is the reason for these results? In PISA's 2012 report, OECD (2014) infers that those excelling in science and problem-based learning may be influenced by a teacher technique that involves teachers initiating metacognitive reflection strategies, affirming that data reported is influenced by teachers. The teacher is portrayed as one of the main reasons for students' performance, teachers have a great impact on student learning. If student performance in science and problem-solving is low, then there is reason to believe that there is also a corresponding level of disparity in teacher performance in science and problem-solving. There are many teacher-related factors that influence student performance (Bandura, 1977; Bartley, 2013; Blackwell et al., 2007; Boaler, 2013; Harris & Sass, 2011, Ingvarson, Meiers & Beavis, 2005; Koballa & Glynn, 2007). It is important to research these factors to increase student performance in science.

When various situations of pressure and judgment arise in students' lives, their young minds quickly lose confidence and build barriers against learning, ultimately affecting performance. Maslow's Hierarchy of Needs hypothesizes that comfort and safety are precursors to learning (Maslow, 1943); once students feels safe, comfortable

and trusting, only then will they open up, realize their potential, be confident enough to take intellectual risks, and succeed academically.

### ***Teacher Performance and Student Success***

According to Maslow's Hierarchy of Needs (Maslow, 1943), for students to succeed, teachers must first create a safe environment and then grasp and maintain students' curiosity during the crucial elementary years of a students' life. When this need is fulfilled, students should have a greater chance of succeeding in school. However, teacher performance isn't just based on simply fulfilling the Hierarchy of Needs for the student. Ontario has created an outline to evaluate teacher performance and has listed specific criteria one must follow to continue teaching (Ministry of Education, 2013).

Specifically, the Government of Ontario uses a Teacher Performance Appraisal (TPA) System to evaluate the performance of teachers. The TPA defines teacher performance based on a number of competencies or skills, knowledge, and attitudes that reflect the Ontario College of Teachers (OCT) *Standards of Practice for the Teaching Profession* (OCT, 2016). The following domains of competency include: committing to students and their learning, possessing professional knowledge and engaging in ongoing professional learning, maintaining a professional practice, and upholding leadership in learning communities. This TPA system is used on all teachers, with emphasis on new teachers.

Principals will conduct TPAs on teachers within their schools, and according to their board's guidelines. Teachers are notified in advance of their TPA and may plan accordingly, choosing which lesson to teach, and preparing the students for a visitor. This may not reflect that teacher's every day performance, which should be the performance

aspect that is measured by the Principal. Regarding this subject-specific TPA, one may wonder whether it is biased. Is it an accurate measure of teacher performance? Principals may be following the same board-approved guidelines, however, teachers may be falsely demonstrating their performance given the time they have to prepare.

TPA documentation is confidential for each teacher. If results show that the teacher unsatisfactorily completes the TPA, the evaluation committee dissects the problem in the teacher's performance and provides suggestions for improvement based on experience and research. The teacher utilizes those improvement plans and a second appraisal, or third or fourth are performed later for the teacher's redemption. The TPA is one application that utilizes research involving teacher performance and applies the theory to practice.

The TPA is a tool that supposedly directly measures teacher performance. However, it has been argued that the real tools to measure teacher performance are the province-wide exams and world-wide tests for students (Steel, Hamilton & Stecher, 2010). These tests, for instance the EQAO (Education Quality and Accountability Office) or the OSSLT (Ontario Secondary School Literacy Test) measure teacher performance indirectly. If your students fail, then as their teacher you have also failed. All the same, I do not believe that any one tool can be used to measure teacher performance. There are too many factors to consider in teacher performance and there is no all-encompassing method of evaluation that addresses every detail behind teacher performance. Brooks and Goldstein (2008) describe the qualities of an effective teacher and compile a list of some factors that influence teacher performance. Briefly, effective teachers understand their impact on their students, believe that all students yearn for success, take time to attend to

the social-emotional needs of students, develop professional relationships with colleagues, act as mentors and role models for the students, create a safe and inviting climate, realize that the greatest obstacle is the fear of making mistakes, and believe that learning and the behaviours of students is a reflection of the teacher (Brooks & Goldstein, 2008). The presence of these factors can influence teacher performance.

There is abundant literature devoted to how teacher performance affects student academic achievement. This literature is significant because school board improvement plans focus on student achievement and are based on the premise that improving teacher quality will improve student achievement (Darling-Hammond, 1998; Hamzeh, 2014; Hargreaves & Fullan, 2012). Teachers have a larger impact on student academic achievement than many other factors, including school resources, instructional interventions, and class size reductions (Odden, Borman & Fermanich, 2004). Nye, Kostantopoulos, and Hedges (2004) determined that 7% to 21% of the variance in achievement gains in students resulted from differences in teacher performance effectiveness.

Through my literature review, I identify two main types of characteristics that influence teacher performance; extrinsic characteristics and intrinsic characteristics. Extrinsic characteristics are those that are externally changeable, such as years of teacher experience, or number of qualifications. Many studies review various extrinsic characteristics of teachers and their effect on student achievement. For instance, teachers with the most experience teaching are most effective when it comes to students' achievements (Clotfelter, Ladd & Vidgor, 2006; Harris & Sass, 2011; Rivkin, Hanushek & Kain, 2005; Rockoff, 2004); the teachers' highest degree earned, their major field of



study, their certification area, and their participation in professional development activities also significantly influence students' achievements (Alvarez, 2008). Contrarily, Mulholland (2004) found that the number of courses studied in science did not significantly affect teacher performance in science. Various studies showing that extrinsic characteristics influence teacher performance have fostered an interest in intrinsic characteristics in teacher performance.

Intrinsic characteristics are those that are internally changeable, such as comfort, confidence, interests, self-esteem, self-efficacy and mindset. Koballa and Glynn (2007) suggested that the following malleable characteristics influence teacher performance: self-esteem, interests, past experiences, and self-efficacy. Some malleable characteristics influencing teacher performance are also connected to extrinsic characteristics, for instance, Kirik (2013) found that teacher candidates majoring in science had a greater self-efficacy than teacher candidates majoring in elementary teaching, indicating that elementary teacher candidates show lower self-efficacy and in turn lower performance achievements than science-majoring teacher candidates. Lekhu (2013) provides supportive evidence to Kirik, suggesting that science-majoring teacher candidates have higher confidence and self-efficacy in teaching elementary science than those who are not majoring in teaching science.

Gaskill and Woolfolk (2002) mentioned that school performance is optimized when self-efficacy and self-regulated learning are utilized; they refer to this combination as the "dynamic duo" (p. 158). They suggest that catering to each student requires a developed awareness of need for an action accompanied by a personal commitment to act, which can be accomplished by following Bandura's four sources of self-efficacy:

modeling mastery experiences, persuasion, and physiological arousal. Gaskill and Woolfolk (2002) believe student performance will improve when teachers “identify the needs of struggling students and offer fundamental guidance” (p. 158), but how can a teacher help a student when they themselves lack the ability to identify and take responsibilities for their struggles? Exploring mindset may offer insight to this.

Little research has been conducted in regards to how mindset affects teacher performance. This is one of the reasons for this study. Perhaps the lack of mindset research in teachers is because “mindset” is a newer concept. Although this study will not utilize professional performance evaluations of teachers, personal reflective performance evaluations will provide insight into whether mindset influences performance and whether it is related to self-efficacy.

### **Statement of Problem**

As early as the 1950s, there has been a persistent stereotype that “pre-service elementary teachers lack what it takes to teach science” (Howes, 2002, p. 846). This disparity of science knowledge creates a cycle whereby teachers pass on their lack of science interest/knowledge to students who will carry this throughout their educational careers. Many of these students will enter fields of undergraduate study other than science, and, of the students who then decide to enter the elementary teaching profession later on, they will also lack science knowledge and will pass it on to their students. It is no surprise that elementary teacher candidates arrive in preparation programs with insufficient understanding of science theories and models (Smith & Scharmann, 1999). Of those teachers who excel in elementary and secondary school science, most of them enter the field of science or choose to teach secondary level science courses; there is a

low chance that elementary level teachers will have the same level of understanding in science content background.

The University of Windsor's (n.d.) entry qualifications for the B.Ed program in the Primary-Junior specialization do not list any specific requirements. The application information website does say that preference will be given to those who have taken any electives that relate to any elementary school subjects, but no specific major is required to become an elementary teacher. This is concerning because without proper expertise in a certain subject there is bound to be discomfort.

The ongoing problem of elementary teachers feeling uncomfortable and unconfident in teaching science is not new. The problem is not simply in teachers not knowing the content, but in not having a coherent, causal understanding - enough though they may feel skilled enough to teach the concept (Parker & Heywood, 2000, p. 89). "Content knowledge is as useless as content-free skill" (Shulman, 1986, p. 8). A teacher who can regurgitate their mastery of science knowledge but cannot figure out where their student is having troubles, is not, by definition, truly "teaching." Researchers have studied this problem for years with no clear resolution (Bursal & Paznokas, 2006; Bursal, 2008; Çakiroglu & Boone, 2005; Goodrum, Hackling & Rennie, 2001; Gunning & Mensah, 2011; Irez, 2006). Many factors have been identified that contribute to the problem, but, over the past fifteen years, self-efficacy in teachers has proven to be of significant interest (Pajares, 2005).

Elementary teachers rate science as their lowest self-efficacious teaching subject (Fulp, 2002). Low self-efficacy in teaching science may be caused by a number of factors, including insufficient content knowledge, inability to conduct experiments, and

the inability to use technology. Teacher self-efficacy in science teaching has been shown to have a direct correlation to student performance and achievements (Mohamadi & Asadzadeh, 2012; Pan, 2014), thus perpetuating the paradigm that low motivated, low achieving, low self-efficacious science educators create low motivated, low achieving, and low self-efficacious science learners (Figure 1). This cyclical pattern of teacher performance was reported as early as 1980 by Blase and Greenfield.

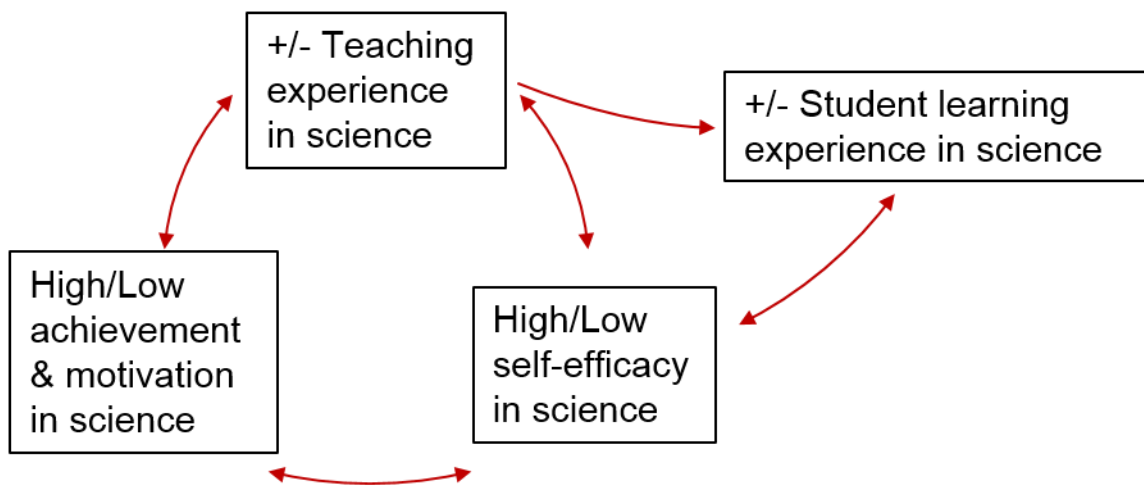


Figure 1. Connection between self-efficacy, teaching science effectively, and student performance in science.

It is suggested that changes in individuals' theories of their own abilities can result in increased motivation and achievement (Dweck, 2008). Research has shown that professional development workshops (McKinnon & Lamberts, 2013; Wingfield, Freeman, & Ramsey, 2000) and methodology classes (Bleicher & Lindgren, 2005; Palmer, 2006; Sanguenza, 2010) can significantly improve teacher and teacher candidate self-efficacy in teaching science. Numerous studies, as highlighted in *Chapter 2: Literature Review*, provide evidence to support the notion that teacher self-efficacy needs to change to increase teaching effectiveness. Self-efficacy may not be the only problem

we need to address to change the paradigm of science teaching/learning. We need to address the root of this problem. Teaching practices are deeply rooted in one's own educational experience (Sarason, 1996). Why does the teacher display low/high self-efficacy in teaching? Can the teacher change? Does the teacher possess the mindset to address their problems in teaching science, to try to improve their teaching performance?

Dweck (2006) describes two types of mindsets: Growth Mindset (GM) and Fixed Mindset (FM). The GM is a dynamic state of intelligence where a person continually works on improvement through high motivation. The FM is a static state of intelligence where a person exhibits a concrete, unchangeable quality with little motivation. Many studies have shown that students are able to develop a GM and that students with a GM possess higher motivation, achievements, and resiliency than students possessing a FM (Dweck, 2008; Duckworth & Quinn, 2009). Dweck has speculated that those with a growth mindset tend to exhibit high self-efficacy, whereas those with a fixed mindset tend to exhibit low self-efficacy. This speculation sparked my interest in determining whether mindset and self-efficacy in teaching science are related. There is little literature quantifiably supporting this notion in students, let alone teachers, but because mindset is the belief in one's intelligence and how one can alter their intelligence through achievement and motivation (Dweck, 2006), it seems theoretically similar to self-efficacy.

A study in teacher mindset to highlight is one by Gero (2013). Gero distributed a Pre- and Post-Mindset Test to determine how professional development is influenced by teacher mindset. Results were inconclusive but showed that improvement of teacher performance in professional learning opportunities could depend on mindset. If teachers'

mindsets influence their professional learning experience and self-efficacy is known to influence teacher performance could mindset also influence their self-efficacy? Or vice versa? Bandura and Wood (1989) proposed a model depicting a relationship between self-efficacy and mindset, referred to as ‘implicit theories of intelligence.’ In my study, I test their model on pre-service elementary teacher candidates to provide insight on a resolution to the stated problem.

### *Overview of Study*

#### *Purpose of the Study*

The purpose of this study is to examine if University of Windsor, Faculty of Education Primary/Junior/Intermediate (JK-8) pre-service teacher candidates’ mindsets are related to their self-efficacy in teaching science. This study also aims to address whether the first year of the new two year B.Ed program influences elementary pre-service teacher candidates’ mindsets and/or self-efficacy.

#### *Research Questions and Hypotheses*

The following research questions frame this study:

- 1) How is self-efficacy related to mindset? – Comparing mindset and self-efficacy survey responses provides insight into whether there is a relationship between self-efficacy and mindset.

#### **Hypotheses:**

H<sub>0</sub>: Self-efficacy is not related to mindset; or

H<sub>A</sub>:

- a. Teacher candidates with high self-efficacy show a GM; and/or
- b. Teacher candidates with low self-efficacy show a FM; and/or

- c. Teacher candidates with high self-efficacy show a FM; and/or
  - d. Teacher candidates with low self-efficacy show a GM.
- 2) Does the first year of the new two-year B.Ed program affect the self-efficacy of elementary teacher candidates? – Analyzing the pre- and post-survey results provides insight into whether the first year of the B.Ed program influences elementary pre-service self-efficacy.

**Hypotheses:**

H<sub>O</sub>: There is no significant difference in self-efficacy and mindset in teacher candidates over the first year in the new B.Ed program; or

H<sub>A</sub>:

- a. There is a significant increase in self-efficacy and mindset in teacher candidates over the first year; or
  - b. There is a significant decrease in self-efficacy and mindset in teacher candidates over the first year.
- 3) What are pre-service teachers' thoughts on how their mindset and self-efficacy affects their science teaching? – Results from the questionnaire demonstrate elementary teacher candidates' understandings of their mindset and self-efficacy. This metacognitive reflection practice is important because it provides insight into problems that elementary teachers face in teaching science.

The study helps to define the problems elementary teachers face when teaching science, and provide insight into how these problems may be solved.

### *Rationale*

Bandura's (1977) theory suggests that self-efficacy has the most malleability early on when learning something new. The first years in the teacher education program are no different than this learning period that Bandura (1977) describes; and, this period could therefore be critical to teachers' long-term development of their self-efficacy. The most powerful influences on teacher self-efficacy are developed during practicum and the induction year (Tschannen-Moran & Woolfolk-Hoy, 2001); this is why pre-service elementary teacher candidates are the perfect participants for this study. Considering that the 2015-2016 academic year is the first year of the two year B.Ed program, teacher candidates are just developing their philosophies on Education and their characteristics as individual teachers. These students are subjected to an intervention all in itself; the classes, observations, colleague interactions, and practica experiences of the first year in University of Windsor's B.Ed program can influence teacher performance. However, this study is unique in that there is no control group as all pre-service teacher candidates are subjected to this intervention year. This study acts as a base model for future research.

In this project, participants take a pre- and post-survey that evaluates their pre- and post- levels of self-efficacy and mindset. From the results, I determine whether the University of Windsor B.Ed program can alter the self-efficacy and mindset levels of the teacher candidates before entering the field as certified teachers. In determining this result, it may provide insight to alleviate the gap in teacher performance and indirectly even out the student performance curve before it begins.

Most achievement-improving evidence based on mindset interventions is conducted on middle school and adolescent students. During adolescence, self-theories



are malleable to interventions, and during this time, staff-executed interventions have a higher chance of helping students reach their potential. The primary role of teachers is to ensure that all students reach their potential (Cotton, 2003), but if some teachers are themselves unconfident and unmotivated, how do we expect them to perform effectively in front of students and motivate them? Research in mindset of students has not been well supported until recently. For educators, very little mindset research has been reported, and furthermore, Bandura and Wood's 1989 model of a relationship between mindset and self-efficacy is not widely studied.

Due to a lack of research in Education with regards to teacher mindset, and the relationship between self-efficacy and mindset, I decided to conduct my study in this field of Education. Furthermore, the participant group in this study is the perfect sample to study because of their theoretical level of malleability in learning as compared to the more seasoned teachers. On an extended timeline, if this study were to continue, I could study the changes in teacher self-efficacy and mindset in my sample as they move on through the second year of the B.Ed program, and possibly even throughout their career as novice teachers.

## CHAPTER 2: REVIEW OF THE LITERATURE

In this chapter, I explore the theoretical frameworks of self-efficacy and mindset, as well as the history of instrumentation in self-efficacy and mindset. I review relevant studies and applications of self-efficacy and mindset in science-teaching, followed by discrepancies in the research.

### **Theories of Academic Motivation and Achievement**

There is a significant relationship between motivation and achievement (Dweck, 1986; Dweck, 2007; Willingham, Pollack & Lewis, 2002). Weiner (1974) describes the relationship as one directional where motivation influences achievement (Urduan & Turner, 2007; Wigfield & Wagner, 2007). Deci, Koestner and Ryan (2001) describe the relationship as cyclical where motivation impacts achievement, which influences motivation to make more achievements, perpetuating the constant cycle. In this literature review, the relationship between motivation and achievement follows the cyclical relationship as it is used in self-efficacy (Bandura, 1995) and mindset (Dweck, 1988). This relationship can be applied both negatively and positively. For instance, if a student fails a test they may feel unmotivated to perform better on their next class due to a lack of confidence in themselves. Low motivation has been associated with the lack of participation in school, which is associated with low academic achievement (Fulk, Brigham & Lohman, 1998). In this sense, motivation acts as a catalyst for academic success (Christensen, Johnson & Horn, 2008). This cyclical behavior can lead to “learned helplessness,” where students will reject a task before completing it (Christensen et al., 2008).

It is important to develop a strong sense of motivation and achievement in students early on because motivation tends to decline with age (Anderman & Mueller, 2010) and respectively with achievement. If teachers can help students maintain a high level of self-motivation, then it is more likely that students will continue maintaining that high motivation, which can lead to higher achievements and a better likelihood of students reaching their potential. It can be a serious problem for many people who do not maintain their motivation and it can often lead to depression (Sideridis, 2005). This cyclical relationship is not only applicable to students, it is applicable to all people. Dweck and Master (2009) suggest that declines in motivation and achievement can be averted by changing one's beliefs about their own abilities.

The following section discusses the theoretical framework behind this study.

### ***Drive Theory***

The building block of the theories of academic motivation is the Drive Theory of Motivation (Atkinson, 1957). According to this theory, motivation is an internal feeling leading to an action. Motivation stems from the drive to achieve and the avoidance of failure. Based on this theory, motives are used as goals to engage students in metacognition and realizing a purpose in their learning.

### ***Attribution Theory***

Another theory of motivation and achievement is the Attribution Theory (Weiner, 1985). This theory states that achievements are explained by or attributable to effort, luck, ability or task difficulty (Weiner, 1985). According to this theory, people can develop a sense of control over their performances. For instance, if students believe that their achievements are results of controllable factors, they will be more motivated to

achieve and will have a greater achievement than if they didn't believe they could control their learning (Urduan & Turner, 2009). Likewise, if teachers believe that their achievements are controlled by effort they will emit more energy into attaining their desired achievement.

### *Social Cognitive Theory*

The Social Cognitive Theory (SCT) (Bandura, 1986), was initially proposed with an emphasis on social behaviours. The theory outlines the perspective that learning occurs in a social context and that learning happens through observation. SCT has several assumptions regarding learning and behavior. It is assumed that contextual or environmental, cognitive or personal, and behavioural factors act in a reciprocal manner in order to influence one's learning and behaviour (Bandura, 1986). Learning in the classroom is influenced by the academic environment, one's own thoughts and beliefs, and the reinforcements one experiences. Another assumption assumes that people influence their own behavior and the environment in a goal-oriented fashion (Bandura, 1986). The third assumption within the SCT is that learning is not an immediate change in behavior; one may possess all necessities to be knowledgeable about the material, but until that person undergoes something that motivates them to apply that knowledge, then they will not have demonstrated that they have learned the concept (Bandura, 1986). The combination of these assumptions that make up the SCT have been applied in many fields.

SCT has been applied to various fields of study to provide sociological understanding of one's performance in that field; fields include education, athletics, mental and physical health, and different careers. This theory has been extensively

applied to the classroom, and focuses on student learning, motivation, and achievement. With regards to academic education, students subconsciously learn the behaviours and attitudes that the teachers emit. Bandura hypothesizes that teachers are an important aspect in student lives because they have the ability to influence their behaviours and attitudes towards certain topics. This theory can also be applied between teachers; for instance, teachers learn how to teach by observing other teachers' lessons, actions, and behaviours. With regards to this study, the theory that observation is an important aspect in learning (Bandura, 1986) is very relevant to concepts in the Theory of Self-Efficacy.

### *Theory of Self-Efficacy*

According to Bandura (1981), "People tend to avoid situations they believe exceed their capabilities, but they undertake and perform with assurance activities they judge themselves capable of handling" (p. 201). Bandura's Theory of Self-Efficacy (1977) predicts that belief in one's capabilities plays a major role in how one actually behaves. Although there are few studies suggesting that belief in one's capabilities is self-debilitating (Vancouver, Thompson & Williams, 2001), there's an overwhelming majority of studies suggesting otherwise. Perceived self-efficacy has repeatedly been shown to enhance motivation and performance attainments. This theory is applicable to all people; however, for the purposes of this study, we will focus on the theory of self-efficacy as it applies to teachers. The construct of teacher self-efficacy is based on the Social Cognitive Theory; the SCT is similar to the theory of self-efficacy with regards to the observational and experiential aspect of learning. Teachers form their perspectives about their professions through experience and observation, and often evaluate themselves on their ability to attain their desired results in teaching.

Bandura describes teacher self-efficacy as the teacher's belief about their ability to teach and meet their desired outcomes for their students (Bandura, 1995). For instance, high teacher self-efficacy promotes a behaviour that exudes effort and persistence. High self-efficacy leads to good performance and subsequent self-reflection of teaching competence. Teachers should always work towards improving their teaching, which increases their teacher efficacy. Self-efficacy beliefs are a great predictor of academic achievements (Bandura, 1977; Pajares, 2005), in this case, towards becoming a better teacher. Bandura's findings lead to the conclusion that improving teacher self-efficacy improves their performance, which results in improved student learning.

Bandura relates teacher self-efficacy to two broader concepts; the perception of one's ability to perform a task and the belief that teachers have certain skills to perform certain tasks that produce desired outcomes. Bandura describes these broader concepts of self-efficacy as "perceived self-efficacy" and "outcome expectancy" (Bandura, 1997).

"Perceived self-efficacy" (also known as "efficacy expectation") is the belief in one's ability to achieve a particular outcome or desire. The causal relationship between beliefs, behavior, and performance lead Bandura to suggest that perceived self-efficacy can be developed through four modes: mastery experiences, vicarious experiences, verbal persuasion experiences, and physiological/affective state experiences. One can develop self-efficacy through a combinations of four modes of perceived self-efficacy. Mastery experiences "provide the most authentic evidence of whether one can muster whatever it takes to succeed" (Bandura, 1997, p. 80), suggesting that being resilient in times of failure can lead to the persistence to succeed. Vicarious experiences are most similar to the SCT in that vicarious experiences are based heavily on observing others' experiences;

vicarious experiences “provide a diagnostic of one’s own capabilities through judging the attainments of others who are similar to oneself” (p. 87). These experiences allow the person to witness a peer’s experiences and perceive themselves in that person’s situation. Verbal persuasive experiences lead to self-efficacy through encouragement and support; “People who are persuaded verbally that they possess the capabilities to master given task are likely to mobilize greater effort and sustain it” (p. 101). Lastly, physiological states will play a role in one’s self-efficacy; “people are more inclined to expect success when they are not beset by aversive arousal than if they are tense and viscerally agitated” (p. 106). Generally a person who is in a mental state of stress will have a harder time becoming successful. This is similar to Maslow’s Hierarchy of Needs, where a person must first feel comfortable, secure and calm, rather than anxious, unsafe, and nervous in order to learn (Maslow, 1943). These four modes are ways in which one may develop expected or perceived self-efficacy, which ultimately influences performance. Henson (2001) indicates that teacher efficacy is malleable, specifically through mastery experiences, where much of the research in self-efficacy focuses.

Another influence on performance is the person’s idea of the outcome of their behaviour. “Outcome expectancy” is the belief that achieving the desired behaviour will lead to the desired outcome. “The outcomes people anticipate depend largely on their judgments of how well they will be able to perform in given situations” (Bandura, 1997, p. 21). Whether the outcomes are attained can influence future self-efficacy. If one fails they may lose their motivation, thereby decreasing their self-efficacy and ability to perform to their potential again. If one succeeds, this may increase their motivation to perform better, thereby increasing motivation and self-efficacy. Outcomes can be used to

influence future actions through motivation and goal-setting. Studies have looked at effects of self-efficacy on goal systems and showed that by “adopting goals, whether easy or challenging, without knowing how one is doing seems to have no appreciable motivational effects” (Higgins & Kruglanski, 2000). There must be a meaningful purpose specific to the goal in order to promote motivation and self-efficacy.

### ***Achievement Goal Theory***

The Achievement Goal Theory of motivation describes how different people have unique goals that influence their decision to participate in activities (Ames & Archer, 1988; Urdan, 2007). These goals (Ames & Archer, 1998) are influenced by two factors, learning goals (similar to what our present education system implements to influence students to master the curriculum) and/or performance goals (desires to be competent to or better than one’s peers). When an individual identifies their learning and sets their performance goals, he/she is more able to stay on track and work towards reaching those goals (Ames & Archer, 1988).

### ***Social Cognitive Theory of Motivation***

Based on the understandings on the SCT, the Attribution Theory and Achievement Goal Theory, Dweck was lead to develop her own theories of motivation and achievement. In her 1999 book on *Self-Theories*, she described how the Attribution Theory offers an explanation of how people “make sense of their world,” attributing failures and successes to intelligence, effort, luck, task difficulty, and ability. These attributions would then influence their motivation to change or surpass their previous outcome. If a person stays optimistic in times of failure and believes that his/her ability is “acquirable” if he/she works hard (Dweck, 1999, p. 141), that person is more likely to set



and attain their goals. Based on the SCT, Dweck and Leggett (1988) proposed the Social-Cognitive Theory of Motivation to answer why individuals in the same situation would pursue different goals. The Social-Cognitive Theory of Motivation is comprised of two key concepts: a) Implicit Theories of Intelligence, and b) goal orientation.

“Implicit theories guide the type of goals people pursue, especially in achievement situations” (Reeve, 2001). Beliefs which take the form of background assumptions can be seen as an implicit theory. Chiu, Hong, and Dweck’s research (as summarized in Kernis, 1995, p. 197 - 216) shows two implicit theories of intellectual ability or, simply put, intelligence: the “entity theory of intelligence” and the “incremental theory of intelligence.” The entity theory explains intelligence as an unchangeable, uncontrollable, fixed trait, whereas the incremental theory explains intelligence as a changeable, controllable, malleable trait (Blackwell et al., 2007; Kernis, 1995). Relating the Implicit Theories of Intelligence to the Achievement Goal Theory, Dweck believes that the incremental theory of intelligence is connected to learning goals and that the entity theory of intelligence is connected to performance goals (Dweck, 2006). Overall, Dweck and Leggett’s (1988) Social Cognitive Theory of Motivation suggests that “implicit theories of intelligence determine the way students approach learning and achievement situations, the goals they adopt, and their achievement they attain through effort and persistence” (Dupeyrat & Marine, 2004, p. 44).

### ***Mindsets***

The Implicit Theories of Intelligence gave rise to Dweck’s work on Self-theories (also known as “Mindset”) (1986). “Self-theories” were developed in regards to the realm of academia and education. “Self-theories” is an all-encompassing category to classify

the functionally harmonious theories of motivation and intelligence, which should naturally lead to achievement. “Self-theories” or “mindsets” describe one’s beliefs about their own intelligence and how they can alter their achievements through motivation to influence their success (Blackwell et al., 2007; Dweck, 1988). Dweck (1986; 1988; 2007) suggests that differences in levels of motivation and achievement may be due to the individuals’ mindsets about their intelligence qualities. The terms “implicit theories of intelligence,” “self-theories,” and “mindsets” are often used interchangeably, however, for ease of participants understanding Dweck uses “mindset.”

Merriam-Webster (n.d.) provides two definitions for “mindset”: “a mental attitude or inclination,” and “a fixed state of mind.” These definitions describe mindset as internal, but they fail to mention that mindset leads to external action and that it can be changed (Blackwell et al., 2007).

Goldstein, Brooks, and DeVries (2013) provide a definition of mindset with regards to educators: “Mindsets are assumptions and expectations we have for ourselves and others that guide our teaching practices and our interactions with students, parents, and colleagues” (p. 74). This definition incorporates both internal and external aspects, and although it does not clearly imply that it can be changed, mindset can be guided. Based on the previously described definitions, in my opinion, mindset is an internal mental dynamic state that can control a person’s attitude and behaviour and has the power to influence others’ attitudes and behaviours.

According to Dweck (2006), there are two types of people: Those who possess a Growth Mindset (GM) and those who possess a Fixed Mindset (FM). The view one

adopts for his/her self affects his/her decisions and attitudes throughout life. This study will utilize Dweck's (2006) identifications of mindset.

A GM is a dynamic state where one believes that abilities can always be improved and that mistakes are learning opportunities to become better (Dweck, 2006). Adopting a GM involves cultivating intellectual skills and other qualities through effort and grit. Duckworth and Quinn (2009) define *grit* as "passion and persistence for long-term goals". Grit is a significant predictor of success (Duckworth & Quinn, 2009). Dweck (1999) suggests that in order to be successful one must experience failure; failure is the most essential step to success. Having a GM creates a passion for learning, especially in the most challenging of times (Duckworth, Peterson, Matthews & Kelly, 2007). When teachers show students how to persist, a GM develops, grit improves, and students overcome challenges (Hochanadel & Finamore, 2015); teachers with GM qualities may be the more effective educators. Brooks and Goldstein's (2007) perspective on the qualities of the mindset of effective educators aligns with Dweck's description of a GM in teachers, particularly where "Effective educators... recognize that one of the greatest obstacles to learning is the fear of making mistakes and feeling embarrassed" (p. 28).

A FM is a static state where one believes that his/her qualities are fixed and are unchangeable; one is born either with or without them (Dweck, 2006). Maintaining a FM involves a sense of urgency to prove that one is good enough and will avoid failure at all costs, but will never struggle or make mistakes to get better. People exhibiting a FM possess low motivation, low effort, and low achievement (Dweck, 2006).

Dweck (2006) explains the importance of mindset using an old test that many people are familiar with. For many decades, many people have utilized the IQ test to

determine one’s intelligence. Alfred Binet actually designed this test to be a diagnostic for children who weren’t benefitting from the Paris education system, suggesting that new education programs could be created and implemented to get them back on track (Dweck, 2006). Many of the participants of this IQ test succumb to their score and believe that it determines their future academic achievements. Dweck (2006) notes that because a fixed mindset is so prevalent in America, that no amount of effort that will raise IQ scores. With this in mind, Dweck uses mindset measures and interventions to bring about positive changes in intelligence beliefs and achievements of students.

Figure 2 summarizes the development of theories from the initial development of the Social Cognitive Theory (Bandura, 1986).

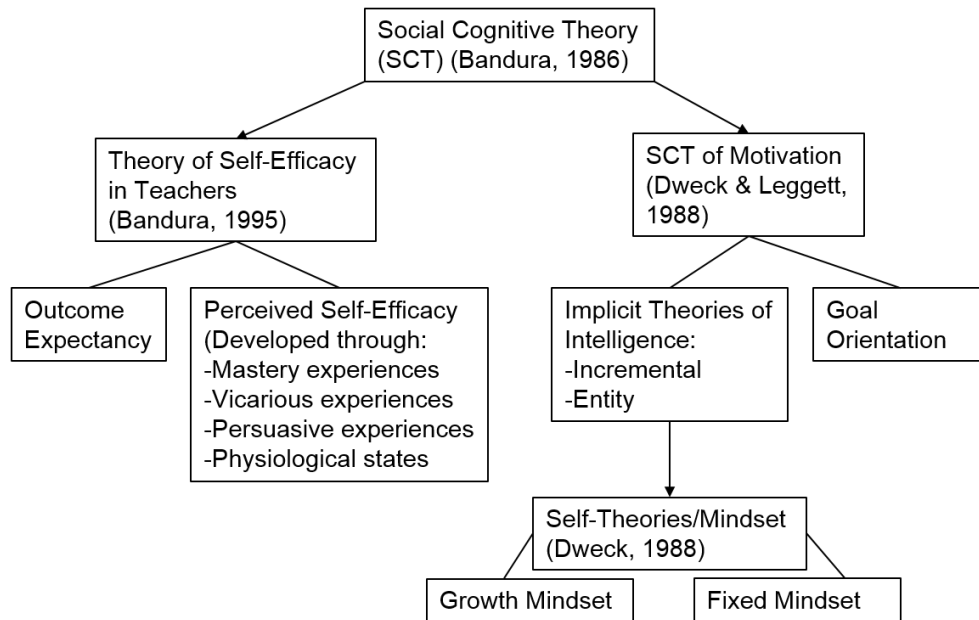


Figure 2. Summary of the development of theories.

***Model Depicting Relationship between Self-Theories and Self-Efficacy***

After the self-theories (Dweck, 1986) and the theory of self-efficacy (Bandura, 1977) were posed, Bandura and Wood (1989) proposed a model to explain the relationship between self-theories and self-efficacy (Figure 3). This is the only model in

existing literature that links the two major motivation theories. They hypothesized that peoples’ self-theory would affect their level of self-efficacy and, ultimately, their performance. Bandura and Wood’s (1989) model has been tested utilizing various tools, but the literature does not address the relationship between the newest form of self-theories, “mindset,” and self-efficacy in science teachers. The present study is framed around Bandura and Wood’s (1989) proposed relationship between self-theories and self-efficacy.



Figure 3. Relationship between self-efficacy and implicit theories of intelligence/mindset (Bandura & Wood, 1989). People who are incremental theorists possess a higher level of self-efficacy than those who are entity theorists.

### *Instrumentation*

#### *History of Instruments to Measure Self-Efficacy*

Many researchers have applied Bandura’s theory of self-efficacy (1977; 1995) in the context of teachers. The following section describes a time line of the instruments that have been developed to measure teacher self-efficacy.

*Webb Efficacy Scale* was developed by Ashton and Webb (1982), who attempted to create a measure of teacher efficacy with a narrow concept of Bandura’s 1977 construct of self-efficacy. Ashton and Webb aimed to reduce the problem of social desirability bias by using a forced choice format of seven items of social desirability. Participants were to determine which option they agreed with the most. However, this

scale was not acceptable and no work has been published with regards to the utilization of the original scale.

Ashton later produced a series of fifty situational questions to address the hypothesis that teacher efficacy is context specific (Ashton, Olejnik, Crocker & McAuliffe, 1982). Teachers were to answer how they would respond to a particular situation, rate their performance effectiveness, and rate their effectiveness with respect to how other teachers have handled the situation. Teachers were also asked to indicate their level of stress that they may undergo in each situation. This instrument is known as the *Ashton Vignettes* (Ashton, Buhr & Crocker, 1984). The *Ashton Vignettes* are not a widely accepted measure because it merely addresses a virtual type of efficacy for teachers who do not actually experience these situations, as opposed to demonstrating their level of efficacy in reality. The two instruments mentioned above are flawed in that they either do not measure self-efficacy as multiple concepts (as recommended by Bandura's (1995) two modes of self-efficacy) or they do not reflect the variety of tasks and demands that a teacher faces (Skaalvik & Skaalvik, 2007).

Gibson and Dembo created the first *Teacher Efficacy Scale (TES)* in 1984. This instrument consists of thirty items that are ranked on a six-point Likert scale. There is a low reliability of the scale because some of the items focused on both personal teaching efficacy and general teaching efficacy, or neither. This instrument is not consistent with accurately identifying the specific factors of self-efficacy.

The *Science Teaching Efficacy Belief Instrument (STEBI)* was developed in 1990 (Enochs & Riggs, 1990). It is a modified form of Gibson and Dembo's (1984) *TES*. It consists of twenty-five items on a five-point Likert scale, ranging from 1-Strongly

Disagree to 5-Strongly Agree. Enochs and Riggs (1990) developed the STEBI to measure the efficacy and outcome of teachers teaching science. STEBI uses two scales to measure different attributes of teaching: Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE). The internal reliability for the PSTE was an alpha of 0.89 and for STOE was 0.76. This implies that it is consistent with itself. The STEBI was used for in-service teachers, but soon after, this instrument was modified to accommodate pre-service teachers; when this occurred, the STEBI for in-service teachers was renamed STEBI-A and the STEBI for pre-service teachers was named STEBI-B. The STEBI-B survey contains 23-statements that are rated by the participants on a five-point rating scale, ranging from strongly disagree to strongly agree. The STEBI instrument tests for levels of self-efficacy as described by Bandura's Theory of Self-Efficacy.

Bandura developed a *Teacher Efficacy Scale (TES)* in 1997 (unpublished), consisting of thirty items on a nine-point rating scale. These items were created by Bandura to address the different experiences teachers undergo that may influence various levels of self-efficacy. The purpose of this instrument was to provide a multi-faceted outline of teachers' self-efficacy without being too specific. The internal reliability held an alpha of around 0.77. This instrument is not used because it lacks in reliability and validity.

The latest instrument designed to test self-efficacy is the *Teachers' Sense of Efficacy Scale (TSES)*, created by Tschannen-Moran and Woolfolk-Hoy (2001). This instrument measures an overall efficacy factor of three domains: efficacy for student engagement, efficacy for instructional strategies, and efficacy for classroom management. Two of the forms were created: one instrument with a twenty-four-item, nine-point Likert

scale and another instrument with a twelve-item, nine-point Likert scale. Tschannen-Moran and Woolfolk Hoy (2001) claim that both forms of the TSES have high reliabilities; however, these tests have not been extensively utilized due to the wide-range ranking scale that may be perceived as confusing to participants. Instruments with items that are ranked on scales larger than a 6-point Likert tend to decrease the likelihood of participants (Chomeya, 2010).

For the purposes of this study, Enochs and Riggs (1990) STEBI-B will be utilized because it analyzes teacher self-efficacy specifically in science education. The majority of studies reviewed in this literature review focus on the use of STEBI-B.

### ***STEBI-B***

Through the Educational Resources Information Centre (ERIC), using the keyword “STEBI”, 38 studies were found that used the STEBI for research in science education. These studies were published from 1990-2015.

There have been inconsistencies reported between PSTE and STOE results, indicating that the PSTE concept may have more significance in determining self-efficacy than the other. Many of these inconsistencies may be due to inappropriate questioning with respect to whether it meets the guidelines of Bandura’s two concepts in self-efficacy and outcome expectancy. A complication with the STEBI was noted by Borchers, Shroyer and Enochs (1992) who suggested that outcome expectancy may not be related to changing teacher behaviours. Although there are some minor discrepancies, the STEBI has demonstrated merit in numerous studies and is a validated quantitative instrument still utilized today.



### *History of Instruments to Measure Mindset*

A questionnaire developed by Henderson, Dweck and Chiu (1992) assessed implicit theories of intelligence. It consisted of three items, each of which depict intelligence as a fixed entity: (1) You have a certain amount of intelligence and you can't really do anything to change it; (2) Your intelligence is something about you that you can't change very much (3) You can learn new things, but you can't really change your basic intelligence. Participants responded to the set of questions using a six-point Likert scale, where 1-Strongly Agree and 6-Strongly Disagree. Higher scores indicated that intelligence does not generally follow the entity theory. Further research found that these high scores were also indicative of intelligence following the incremental theory. However, some problems arose with this questionnaire. With respect to subject domains in education, would it show domain generalizability? They compared the implicit theory model of intelligence to domains other than intelligence (such as morality and talent), and found that although the measures are the same format, the domains show independent results. This suggested that implicit theories are subjective. Another issue that arose was whether three items on the questionnaire were sufficient to truly describe one's implicit theory. The high internal reliability of measure ( $\alpha=0.96$ ,  $N=50$ ) suggested that three items on the questionnaire were no problem. However, to gain more accurate information from the data with regards to intelligence, Dweck created a more extensive questionnaire to address multiple factors that may influence intelligence.

Erdley and Dweck (1993) developed the Implicit Theories of Intelligence Scale (ITIS) for Children. Similar to the implicit theory of intelligence test from 1992, the statements are rated on six-point Likert scale, but there are six items instead of three.

Scores are averaged to reveal where they fall in the entity-increment continuum. Those with scores lower than 3 represent a fixed entity intelligence and those with scores higher than 3 represent an incremental intelligence. The internal consistency showed a reliability of alpha 0.82 to 0.97 (Chiu, Hong & Dweck, 1995). However, the measure encouraged the entity theorists to answer questions based on an incremental response, which suggested that the incremental choices were too compelling for the test to be utilized (Erdley & Dweck, 1993).

Later in 1999, Dweck refined and expanded the ITIS to contain four incremental and four entity theory items. The statements were worded so that “you” was utilized as a way to initiate the participants’ metacognition. Items were rated on a six-point Likert scale, with 1-Strongly Agree and 6-Strongly Disagree. The incremental scale items are reverse-scored. Total scores were added and the higher scores were more representative of entity theorists. The scale is unaffected by various potentially confounding variables, such as social desirability, intellectual ability, and self-presentation concerns, which support the validity of the scale. This scale is known as the General ITIS because it is argued that the “you” statements may idealize the participants’ general implicit theories, which may not be about their own abilities (DeCastella & Byrne, 2015). Hong, Chiu, Dweck, Lin and Wan (1999) reported that the original ITIS’s validity is based on three sample sizes ranging from  $N=32$  to  $N=148$ , producing reliability Cronbach coefficients ranging from 0.94 to 0.98.

Dweck also created a Self-Theory version of the ITIS (Dweck, 1999). This scale used all items from the General ITIS, but reworded them as first-person claims. This rewording allows participants to provide answers that focus more on their past

experiences, where they can answer the statement as more of a claim about what they have already done. Scoring tactics were the same as in the General ITIS. Internal consistency showed a reliability of alpha 0.90.

Released in 2006, Dweck created a sixteen-item, six-point Likert scale test (1-Strongly Agree, 6-Strongly Disagree). This Mindset instrument is publicly available on Dweck's own online platform, [www.mindsetonline.com](http://www.mindsetonline.com), allowing anyone to electronically determine the type of mindset they possess. This test is also the most similar to Dweck's General ITIS, containing all of the eight "you" statements regarding intelligence, as well as another eight "you" statements regarding talent. This Mindset Test differs when compared to the General ITIS because it evaluates the implicit theory of talent as well as the implicit theory of intelligence. Considering that this instrument is recently released and still contains statements that were utilized in the General ITIS instead of items used in the Self-Theory ITIS, it seems as though the General ITIS is more supported.

Blackwell and colleagues (2007) created another Mindset Test as part of their experimental intervention program, Brainology™, for grade six students. This Mindset Test for students is composed of thirty-one items that are rated on a six-point Likert scale, with 1-Strongly Agree and 6-Strongly Disagree. The statements are divided into three domains: self-theories of intelligence, mistakes/failure, and effort. The internal reliability of the questionnaire was reported to be  $\alpha=0.78$  with a sample size of  $N=373$ , and  $\alpha=0.77$  with a sample size of  $N=52$  (Blackwell et al., 2007). This test was specifically geared towards students; however, a newer Mindset test has emerged which has greater generalizability in terms of participants.

For the purposes of this study, the General version of the ITIS will be used because it caters to the participants of this study. The Self-Theory ITIS is not used because I believe that it offers a more forward approach for participants to respond to the statements based on their past actions. Whereas the General ITIS is more predictive, allowing participants to think about whether they think that they agree with a statement. This also allows participants to become more reflective and incorporate metacognition in their actions after taking the pre-test, which is beneficial in this study because the B.Ed program is focused on reflective measures. Also the Self-Theory ITIS “I” statements, may bring about a response that incurs a sense of complacency that may encourage participants to remain in that state of thinking and not work on improvement.

#### ***Mindset/Implicit Theories of Intelligence Scale***

Through the Educational Resources Information Centre (ERIC), using the keywords “Implicit Theories of Intelligence Scale”, 9 studies were found that used the ITIS for research in education, but this was not specific to teachers. These studies were published from 1971-2015. When I used the keywords, “Implicit Theories of Intelligence Scale + teachers,” only 3 studies were found that used the ITIS for research in education, and the search’s results were not specific to science-teaching. These studies were published from 2010-2013. The few studies gathered from the research displays the lack of mindset research with teachers.

Although a recent study (DeCastella & Byrne, 2015) suggests that the Self-Theory ITIS is a “better predictor of achievement, motivation and student disengagement,” the General ITIS will be utilized in this study because of reasons mentioned above. The General ITIS does pose some redundancies amongst the

statements, where some statements that represent a fixed mindset are rearranged to convey the opposite, however, these redundancies are necessary to ensure that participants are responding consistently. Using the General ITIS test in this study will also help contribute to the validation of the instrument.

### **Studies of Self-Efficacy in Teaching Science**

Self-concepts decline during adolescence (Blackwell et al., 2007), and as one ages he/she does not develop his/her self-concepts further. Studies suggest that many elementary school teachers feel uncomfortable and not confident in teaching science (Bursal & Paznakos, 2006; Bursal, 2008; Çakiroglu et al., 2005; Goodrum et al., 2001; Irez, 2006). Wu and Chang (2006) identified three confidence-related problems in teaching science: low content knowledge in science, the inability to perform experiments and the inability to use technology. These unconfident feelings are connected to low self-efficacy in teaching science (Buss, 2010; Swars & Dooley, 2010). According to Fulp (2002), elementary school teachers evaluated science as their least self-efficacious teaching subject. What causes the low self-efficacy, and what has been done to help teachers improve their self-efficacy? Many studies have also been conducted to explore reasons for low self-efficacy.

### ***Self-Efficacy in Teachers***

It was widely studied that a strong content background of science relates to a higher level of teacher self-efficacy belief and better quality of teacher performance (Pajares, 2005; Posnanski, 2002; Shrigley and Johnson, 1974). Kirik (2013) examined a number of other factors that are influential to the science teaching efficacy of pre-service elementary teachers. Kirik explored antecedents, conceptual understandings, class

management beliefs, and science-teaching attitudes in both teacher candidates with and without a science background and determined each factor's relation to self-efficacy. Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE) were measured, following Enoch and Riggs' (1990) STEBI-B. Kirik found that teacher candidates majoring in science had a greater PSTE than teacher candidates majoring in elementary teaching, suggesting that elementary teacher candidates show lower self-efficacy than science-majoring teacher candidates. Lekhu (2013) provides evidence supporting Kirik's (2013) finding that science-majoring teacher candidates have a higher confidence and self-efficacy in teaching elementary science than those who are not majoring in teaching science. Returning to Kirik's (2013) study, he found a small significant positive correlation between science concept knowledge and STOE, a strong significant positive correlation between science teaching attitude and PSTE/STOE, and a positive relationship between the number of science methodology courses and science teaching attitudes, and no significant relationship between class management beliefs and efficacy.

In addition to Kirik's (2013) findings, there is another possible factor that affects teacher's self-efficacy. Quality science teaching may be impeded by teachers' lack of experiences with innovative science activities. The emergence of the "inquiry-based" teaching model in science education reform has reframed teachers' methodological expectations for teaching (Smolleck, Zembal-Saul & Yoder, 2006). Teachers are not only expected to teach in accordance with a science curriculum, but they are also challenged to teach science following the open-ended inquiry-based model. Teaching inquiry-based science requires certain behaviours and attitudes that contradict the traditional teaching

methods that teachers were taught as students. The introduction of this new model may contribute to teachers' low self-efficacy in teaching science because teachers may be unaware of it and how to implement it (Hamzeh, 2014), or they may have a misunderstanding that it requires extra time and money and thus they do not make an effort to teach following the inquiry-based model (Windschitl, 2002). Research shows that the teaching practices of low self-efficacious teachers do not support the inquiry-based model (Smolleck et al., 2006; Yusuf, 2013).

Other reports suggest that teachers' past experiences are an alternate factor that affects self-efficacy. For instance, ill-prepared teachers with past negative experiences in learning science foster teachers who have higher anxiety in teaching science. These teachers are more likely to avoid teaching science (Palmer, 2008; Swars & Dooley, 2010), or become less confident in teaching it (Bleicher & Lindgren, 2005; Bursal & Paznokas, 2006). This perpetual pattern must be changed if we want students to gain technological skills in science and develop critical thinking and meaningful collaboration in science.

In what ways can these self-efficacy issues in elementary school teachers be avoided or solved? The following sections describe methods used to decrease the occurrence of low self-efficacy in teaching science to elementary students: professional development workshops, methodology courses, reflective teaching, peer-coaching and lesson-study. The purpose of all methods was to increase teachers' cognitive content to ease teacher anxieties, which should increase their confidence and self-efficacy to provide better learning experiences for their students. Increased self-efficacy has also been shown to increase novice teacher retention rates (Kelley, 2004).

### ***Improving Self-Efficacy in Teachers***

Numerous studies have found evidence promoting methods courses and professional development (PD) workshops to improve elementary teacher self-efficacy (Bruce, Esmonde, Ross, Dookie & Beatty, 2010; McKinnon & Lamberts, 2013; Posnanski, 2002; Swars & Dooley, 2010). The following section will describe some evidence supporting self-efficacy improvements, based on the constructivist approach to teaching and learning.

#### ***Professional Development Workshops and Self-Efficacy***

Wingfield and colleagues (2000) initiated a site-based pre-service professional development program where teacher candidates would go to an elementary school and observe the residing teachers. This study combined lesson-study with peer-teaching to attempt to improve teacher candidates' self-efficacy. When the observation was completed, the teacher candidates created a collaborative lesson. The teacher candidates reported feelings of more confidence and higher self-efficacy after completing this PD workshop than before the workshop. Teacher candidates' PSTE increased after observing teachers in action.

Posnanski (2002) studied self-efficacy beliefs through a professional development program implemented in an in-service course for elementary science teachers. The PD program was based on a constructivist approach to science teaching that incorporated inquiry and self-reflection. Under the constructivist method, teachers learn about science and science teaching just as students should learn science in schools. This study analyzed the factors involved in an effective staff development program and used these factors to create a program geared to alter science teacher self-efficacy beliefs. Forty-three



elementary teachers from a school in the United States participated in an extensive PD training program that aimed to improve self-efficacy in science teaching through analyzing curricula design and implementation, and learning about innovative teaching strategies that followed the inquiry reform. Before commencing the PD workshops, teachers completed a pre-STEBI-A survey. Following the PD workshops, teachers completed a post-STEBI-A survey. Open-ended questions were also administered. Teachers were required to keep reflective journals to track their experiences throughout the program. Results show that the majority of participants agreed that the program had a positive impact on their ability to use inquiry-based activities. STEBI-A results showed that after the PD program teachers were more comfortable in teaching science and had significantly higher levels of self-efficacy, but showed no significance of change in outcome expectancy. It was suggested that the discrepancy in the PSTE and STOE sections of the STEBI-A test may be because the program may not have immediately impacted the participants' confidence to administer the strategies, and that they may need more time to reflect and determine how they would go about the implementation phase of their newly learned inquiry strategies (Posnanski, 2002).

McKinnon and Lamberts (2013) explored an inquiry-based workshop that positively influenced science-teaching self-efficacy of primary school teachers. This Australian study provided short external PD workshops, held in science centers, for primary school teachers. The PD workshops promoted inquiry-based learning with hands-on, curriculum-friendly activities using every day materials suited for the classroom. They studied the influence of these inquiry-based learning workshops on the teachers' self-efficacy. Interviews were conducted, and the STEBI was used to measure the self-

efficacy and outcome expectancy of each teacher. Participants wrote a pre-STEBI survey, attended four short PD workshops over one year, and then participants wrote post-STEBI surveys immediately following the workshops, 4 months after the workshop, and 11 months after the workshop. Results from the post-STEBI showed that both pre- and in-service teachers exhibited increased self-efficacy beliefs for at least 11 months after the PD workshops ended. Results also showed that pre-service participants had higher outcome expectancy scores than what they had recorded in the pre-STEBI. In-service participants' outcome expectancy scores did not significantly differ between the pre- and post-STEBI. Overall, pre-service participants benefited the most from the workshops as compared to the in-service teachers. However, the in-service teachers noted that the influence on effectiveness of PD depended on their school environment and whether the school was supportive of science. One cohort reported a more supportive science teaching school environment, which showed higher STEBI scores. Interviews revealed that teachers' previous science experiences influenced their perception of science and their self-efficacy in teaching science. Past negative experiences in science may lead to negative attitudes towards teaching science, but these situations may be altered through external PD workshops as shown in one of the teacher's experiences. Although interviews showed that old beliefs may still be an influence in teaching science, self-efficacy still showed improvement through the PD workshops.

A more recent, familiar study conducted by Hamzeh (2014), at the University of Windsor, involved Japanese Lesson Study as a means of PD. Lesson Study is commonly studied in Math education, with little research in science education. This study involved twelve pre-service teacher participants (including myself) who collaborated and co-

planned two grade ten science, inquiry-based lessons which were performed in a practicum placement and observed by the participating teacher candidates. Hamzeh (2014) used STEBI-B and ASTQ (Attitude towards Science Teaching Questionnaire) instruments pre- and post-study, followed by focus group interviews. The STEBI-B results suggested that there is an increase of self-efficacy through lesson-study. The ASTQ results suggested that participants had positive attitudes towards teaching science, with minor concerns in teaching future science content, being unable to answer students' questions, and being comfortable enough in choosing science as one of the preferred subjects to teach. A comparable lesson-study PD program by Chong and Kong (2012) examined interview data and reflective exercises that also documented the notion that teachers felt an improved sense of self-efficacy. The studies by Wingfield and colleagues (2000), Posnanski (2002), McKinnon and Lamberts (2013), and Hamzeh (2014) present evidence coherent in supporting PD workshops to increase self-efficacy.

### ***Science Methodology Courses and Self-Efficacy***

Efficacy beliefs provide a sense of how pre-service teachers perceive their strengths and preparedness as a future science teacher (Cakiroglu & Boone, 2005). Self-efficacy measures showed to be higher after completing B.Ed science methodology courses than before taking the courses (Bleicher et al., 2005; Sangueza, 2010). This indicates that by the end of the B.Ed program, pre-service teachers are more confident and prepared to teach than they were at the beginning of the program.

Sangueza (2010) determined that pre-service teachers show statistically significant improvements in self-efficacy throughout the duration of a science methodology class. Sangueza (2010) conducted a year-long study that utilized a mixed-

methods approach which composed of pre- and post-STEBI-B surveys, observations, interviews and other data collection methods and a dual phase study of two separate pre-service teacher sample groups to determine the sources of efficacy and their impact on science teaching practices. ANOVA results showed a statistically significant increase in self-efficacy of pre-service teachers by the end of the science methodology course and throughout teacher candidates' practicum experiences.

Bleicher and colleagues (2005) employed a mixed-methods design involving reflective journals a science conceptual understanding test, pre- and post-STEBI-B tests, and focus-group discussions. Forty-nine pre-service elementary teachers were divided into two groups, each group lead by a different professor. Participants took a six-week summer science methods course as a mandatory requirement towards their B.Ed. The study showed that many of the elementary pre-service teachers had a weak background in science content knowledge and had concerns about whether they could meaningfully teach science to children. By the end of the course, all of the pre-service teachers overcame their concerns and there was a significant difference between the pre- and post-test self-efficacy. Overall, the methods course played a significant role in the pre-service teachers' development of science concept understanding.

Gunning and colleagues (2011) conducted a case study on a science methodology class of twenty-three elementary teacher candidates to determine if self-efficacy could be developed through various class activities and projects. At the beginning of the methodology class, fifteen out of twenty-three of the participants said that they did not see themselves as a science teacher. At the end of the methodology class, of those fifteen participants, ten of them changed their views and could see themselves as science

teachers. The methods course requirements allowed teacher candidates to develop the “mastery experience” mode of self-efficacy (Bandura, 1997) through hands-on lab activities, assignments, and science lessons applied in the methodology classroom and the pre-service field placements. The other modes of self-efficacy were developed in the classroom environment through reflection and collaboration. Pre-methodology observations indicated that participants’ lack of experience in science influenced negative self-efficacy. Upon completion of the methods class, participants reported an increase in self-efficacy after taking part in the assignments for the course (mastery experiences). Participants also reported that the increase may be explained by their dialogue between colleagues (vicarious experiences).

The studies by Sanguenza (2010), Bleicher and Lindgren (2005), and Gunning and Mensah (2011) present evidence coherent in supporting science methodology courses to increase self-efficacy.

### ***Reflective Teaching Practices and Self-Efficacy***

A recurring theme amongst some of the studies aforementioned is reflection. Lieberman and Miller (1992) defined teacher development as a “continuous inquiry into practice” (p. 106); teachers are reflective practitioners who follow a constructivist approach to re-think and re-evaluate their instructional practices and the outcomes that those practices have on their students (Cruickshank, 1990). Reflection empowers teachers to make instructional improvements while constantly developing their pedagogical views.

Reflection is a very important aspect in teacher education. Dewey (1933) proposed that reflection acts as a coping mechanism for teachers who experience problems that occur in a classroom setting. Bandura (1986) considered self-reflection as

an important personal attribute that influences ones' ability to alter thinking and behaviour.

Volkman (1992) studied the effects of field-based reflective practice on pre-service teachers' self-efficacy. Twenty-four teacher candidates participated in the study while completing one of their 4-week practica experiences needed to fulfill the requirements of their B.Ed. Half of the teacher candidates received a workshop-like conference from their graduate observer following each observed lesson, which helped the teacher candidates to make sense of any confusions they had while teaching. The other half of the teacher candidates acted as a control group, receiving no help in reflection from discussion with a graduate observer. When the teacher candidates regrouped, reflection, rethinking, and sharing experiences helped bring a new meaning to their practices. Results suggested that sharing experiences positively impacted teacher candidates' self-efficacy.

When teacher reflection is a part of practicum experiences, teacher retention rates in schools increase (Kelley, 2004). Research suggests that teachers who use critical reflection throughout their teacher education experience encourages novice teachers to use critical reflection as a problem-solving tool which may in turn decrease teachers' desire to leave the profession (Kelley, 2004). Kelley determined that teacher retention is related to high levels of teacher reflection involving the self-evaluation of teacher self-efficacy.

Yost (2006) qualitatively examined reflection and self-efficacy as factors in teacher retention. Interviews and observations showed that novice teachers' successes were in large due to the teachers' self-efficacy. Furthermore, the teacher self-efficacy,

which in this study was derived from successful student teaching experiences and the ability to use reflection, outweighed most other factors in the novice teachers' successes. The study showed that if a novice teacher with high self-efficacy felt that the school was a poor match for them, they would transfer to another school rather than a teacher with low self-efficacy who completely abandoned the profession and most importantly, their students.

In PISA's 2012 publicly-available report, OECD (2014) infers that those excelling in science and problem-based learning may be influenced by a teacher technique that involves teachers initiating metacognitive reflection strategies, suggesting that data reported is influenced by teachers' ability to reflect on their teaching practices. Many teacher education programs incorporate classes or workshops that emphasize the importance of reflection which should, according to the research, lead to improved self-efficacy, which should in turn positively influence student performance. Despite the efforts to improve teacher performance to improve student performance, PISA (2014) results show that we still have students not meeting standards.

It is a constant issue that pre-service elementary teachers are weak in content knowledge and scientific practice. As reviewed, there are successful professional development and methodology course programs designed to help teachers become comfortable in teaching science. However, it is unlikely that new teachers will meet all of the needs in their first year of the educational system, and it is inevitable that some may become discouraged from the profession. Teaching is a constant process, and novice-level teachers have much to experience. I believe that it is those who are self-efficacious, persistent, resilient, creative, metacognitive, and reflective who succeed in the teaching

profession. However, these qualities can be difficult to cultivate if one is stuck in their traditional ways of teaching and learning.

### *Studies of Mindset*

Self-theories or “mindsets” create a “whole motivational framework” for students and place a particular value on effort (Dweck & Leggett, 1988). Students’ beliefs about the nature of their intelligence can often predict performance in academic situations during middle school (Dweck & Moldne, 2007). Dweck (2009) suggests that the discrepancies in academic achievement may emanate from students’ self-theories about the nature of their intelligence- this not only includes their beliefs about their intelligence but also their motivation to alter their achievements.

### *Improving the Mindset of Students*

Blackwell and Dweck (2007) created a Growth Mindset Workshop for seventh graders, where the students were split into two groups. The control group received sessions of study skills and showed no improvement. The GM group read an article called, “You Can Grow Your Intelligence: New Research Shows the Brain Can Be Developed Like a Muscle,” and received lessons that changed their attitudes towards school. A thirty-one-item Mindset Test was given before and after the intervention stage. Student reviews from the GM group described how they once thought that school was a place to perform and be judged, but now they could see that they were in control of their brains and they had an active role in their education. The GM group showed a significant increase in their math grades, and demonstrated more effort into their learning, homework, and studying. From this study, they created a wider available computer program called, “Brainology™” (Duckworth & Quinn, 2009).



Launched in 2008, Brainology™ offers six modules where students learned about the brain and how to improve its function. The majority of students participating in this study spoke highly of the program, and commented on how it improved their learning process. Brainology™ not only improved achievement in the students, but it also improved resiliency and behavior of the students in the face of adversity. It was concluded “what students believe about their brain – whether they see their intelligence as fixed or something that can grow and change – has profound effects on their motivation, learning and school achievement” (Duckworth and Quinn, 2009, p 166).

Saunders’ (2013) study explored at-risk 6<sup>th</sup> grade students’ mindsets and Brainology™’s impact on their reading achievement. The study shows insignificant results in reading achievement after utilizing Brainology™. A mixed-methods approach of a Mindset Test, the Elementary Reading Attitude Survey, the Measures of Academic Progress survey, and focus group interviews were conducted in a quasi-experimental setting. The purpose of this study was to examine the impact of Brainology™ on 6<sup>th</sup> grade students reading achievements and attitudes towards reading. A sample of at-risk sixth grade students was split into a treatment-Brainology™ group and a non-treatment group. After the treatment group completed the Brainology™ intervention, their reading achievement level, attitudes, and mindset did not show significant results. Although ANOVA results showed no significant differences between students in the intervention and students not in the intervention, seven of eighteen students from the intervention group did increase their achievement, mindset, and attitude scores by at least three points. A Pearson Correlation test between reading achievement and mindset of these students

was conducted, and showed low significant correlations between achievement and mindset.

### *Physiology of a Brain Exhibiting a Growth Mindset*

Scientific research in the cognitive psychology and neuroscience fields has expressed interest in the growth mindset idea. Studies have shown that neuronal connections increase in students who adopt a growth mindset, thus supporting the hypothesis that intelligence is malleable in those with a growth mindset (Ramsden, Richardson, Josse, Thomas & Ellis, 2011).

When mistakes are made, synapses fire and neural pathways are created to build the connections in the brain and thus make the child “smarter.” This process is referred to as “neuroplasticity.” Adults possess an average of half the amount of synapses that children experience. Neurons in adults that are used most often develop stronger connections, while those that are rarely used eventually die (Doidge, 2007; Mahncke, Bronstone & Merzenich, 2006). Critical periods of neuroplasticity develop in childhood (Mahncke et. al, 2006), firing around 15,000 synapses per neuron and decreasing with age (Mundkur, 2005). This makes children very suitable candidates for cultivating growth mindsets because, as the brain is “growing,” we can easily help students develop a passion for learning through persistence, effort, and acceptance of mistakes easier than we can with adults. Although aging adults experience reduced brain activity and a natural loss in brain function, research shows that with training, adults can redevelop their brain plasticity and malleability (Bruno, Merzenich & Nudo, 2012; Mahncke et. al, 2006) and hopefully their mindset.

### *Mindset in Adults in Education*

Considering that Mindset is a fairly new concept, there is very little research conducted on teachers and very few interventions. A study worth mentioning is one by Dupeyrat and Marine (2004) that tests Dweck's 1988 model of social-cognitive theory of motivation. This study is reviewed because adult students returning to a school setting may possess some similar characteristics of pre-service teacher candidates in a B.Ed program. They conducted a study on 76 French adults who were returning to complete their high school education. Participants each completed a 121-item questionnaire that assessed various factors of student motivation and academic participation, and was rated on a four-point Likert scale. It included an adapted version of the Implicit Theories of Intelligence Test (Chiu, Hong & Dweck, 1992), a goal orientation subscale, two other subscales that measured the level of cognitive engagement in learning, and a final examination to measure their achievement in the courses (Dupeyrat & Marine, 2004). Although this study tested Dweck's 1988 model of social-cognitive theory of motivation, it is significant because it tests the earliest model that lead to mindset and it provides some insight into the credibility behind her theory. Through an extensive analysis they determined that neither of the implicit theories could predict performance goal orientations, but that the entity (fixed mindset) theory could predict mastery goal orientations; suggesting students who believe their intelligence is a fixed entity are more likely oriented toward mastery goals. They also found that the negative influence of having a fixed entity is countered by the positive effects that mastery goals have on effort; which implies that although one may have a fixed mindset, it may have an arbitrary value depending on how hard you work towards achieving your goal. Results

showed that mastery goals and effort are significant predictors of achievement. This study is significant because it shows that mindsets may not have an influence on performance goals and that performance goals may be attained through effort regardless of the mindset. This study in particular furthered my interest towards whether mindset and self-efficacy are related.

Another study (Komarraju & Nadler, 2013) conducted on adult undergraduate students found that students who have high self-efficacy in their academic performance were more likely to believe that their intelligence is malleable (incremental/growth mindset) based on their efforts. They used the eighty-one-item, seven-point rating scale, Motivated Strategies Learning Questionnaire (Pintrich, Smith, Garcia & McKeachie, 1991), to evaluate self-efficacy. They used the General ITIS to evaluate 257 students implicit theories of intelligence, with an internal reliability of 0.88 (entity) and 0.89 (incremental). A study of identical methods was conducted in Turkey and it presented similar findings that undergraduate students with low self-efficacy believed that their intelligence was a fixed entity (Yaman, 2015). These studies provided further insight into a relationship between self-efficacy and implicit theory of intelligence/mindset in adults.

Gero (2013) of Claremont University composed a mindset test directed specifically towards teachers undergoing professional learning activities. His goal was to test Bandura and Wood's 1989 model of the relationship between self-efficacy and self-theories. 338 teachers participated in the research. Each took a TSES test as a measure of self-efficacy. Mindset was measured using an original test based on Dweck's mindsets; 3 statements geared toward a FM, and 4 statements geared toward a GM. Those who agreed with the 3 statements represented a FM. Those who agreed with the 4 statements

represented a GM. The original Mindset Test used in this study had a reliability alpha of 0.727. Results suggested that most teachers possessed a high level of self-efficacy, and that most teachers supported the incremental teacher mindset more than an entity mindset. Results suggested that the improvement of teachers in professional learning opportunities may depend on mindset and that mindset is a significant predictor of teacher self-efficacy.

Woolfolk and Hoy (2009) also suggested that research has not addressed this connection, and that teachers with a higher self-efficacy will empower their student to become active, strategic and effortful in addressing challenges. The authors indicate that teachers with a higher self-efficacy may inherently possess incremental thought and belief patterns (Woolfolk & Hoy, 2009).

### **Studies of Mindset and Self-Efficacy**

Bandura and Wood's (1989) model depicting a relationship between mindset and self-efficacy was proposed by experimentation. They assigned graduate students with similar levels of self-efficacy to either an entity theory group or an incremental theory group. Each group was to complete a decision making-project. The entity group was told that decision-making is reflective of cognitive ability, and the incremental group was told that decision-making is reflective of practice towards improvement. Qualitative observations and qualitative self-evaluative efficacy data showed that those who performed in the entity group experienced a loss of self-efficacy, and those who performed in the incremental group experienced a gain in self-efficacy. The study showed that self-theories can influence self-efficacy. Few other studies were performed that supported their model.

A dissertation by McWilliams (2012) tested Bandura and Wood's (1989) model. She utilized the Ohio State Teachers Sense of Efficacy Scale (Tschannen-Moran & Woolfolk Hoy, 2001), the Implicit Theories of Intelligence Scale, and an Assessment of Teacher Enjoyment, Anxiety and Anger Related to Teaching to test implicit theories, self-efficacy and emotional outcomes of teachers in general. McWilliams (2012) found that incremental beliefs correlated with higher self-efficacy in models that didn't involve emotional outcomes, but the overall relation between implicit theory and self-efficacy was not significant. This study provided findings that do not support Bandura and Wood's (1989) model.

Hubacz (2013) conducted a longitudinal study to compare self-efficacy and implicit theory of intelligence in math teachers and their effects on student achievement in the United States to determine a relationship between mindset and self-efficacy in teachers and their effects on students. She used data collected from all schools in the United States via the Educational Longitudinal Study from 2002 and performed a multiple regression analysis. The study surveyed tenth grade math students and their corresponding teachers, and followed them over a ten year period. Student math achievements were weakly associated with teacher experience and teachers. But female teachers tended to have a higher level of efficacy. An important result explained that there was a weak correlation between high self-efficacy and an incremental intelligence (growth mindset) and low self-efficacy and entity intelligence (fixed mindset). This result is significant because it is contrary to what is described by Bandura and Wood's 1989 model, where the level of self-efficacy should increase as mindset becomes more

malleable and vice versa. The relationship between self-efficacy and mindset is not as clear as it was hypothesized.

My project is most closely comparable to Hubacz (2013) but offers insight to Canadian certified teachers' mindsets and self-efficacy, particularly in science teaching.

***Discrepancies in Elementary Teacher Mindset and Science-Teaching Self-Efficacy***

Many studies have been conducted regarding elementary teachers' motivation, achievement and intelligence by improving self-efficacy and few have been conducted for mindset. These two studies mentioned above did not confidently define a relationship between self-efficacy and mindset in teachers. As the results are unclear, research must continue. If there is a relationship, is it generalizable? Is it subject specific? Maybe we need to consider creating subject specific tests in order to answer this question.

Since the definitions of mindset and self-efficacy seem to overlap, do Dweck's Mindset instrument results align with Enoch and Riggs' STEBI-B results? Each instrument tests a different quality, but research suggests that self-efficacy and mindset are somehow related. If a growth mindset quality is reflective of high self-efficacy in teaching in general, can it also predict the self-efficacy in science teaching?

Throughout my three years of experiences as a B.Ed and M.Ed student in the Faculty of Education at the University of Windsor, it has been my general observation that elementary pre-service teacher candidates lack confidence and self-efficacy in teaching science. I have also observed that of the teacher candidates who seem to possess growth mindset qualities, these qualities somehow disappear when it comes to teaching science or other subjects that they are unfamiliar with. If self-efficacy and mindset are related as per Bandura and Wood (1989) then there is a discrepancy in teacher mindset

and science-teaching self-efficacy. If a teacher can be optimistic and open to learning and “growing” their intelligences in so many aspects of teaching, but when it comes to a specific subject (in this study, science) they suddenly change their mindset, why does this mindset alteration occur? I think that studying self-efficacy and mindset can shed light on this discrepancy.

### **Conclusion**

Of the important contributions from the extensive body of literature, there is still an absence of research that provides evidence to support a link between mindset and self-efficacy in elementary pre-service teachers teaching science. The studies discussed in the review show preliminary evidence that teachers exhibit different implicit theories about certain subjects and that their theories may be related to their self-efficacy in teaching. The current study investigates whether teachers’ self-efficacy relates to their implicit theory/mindset.



## CHAPTER 3: METHODOLOGY

In this chapter, I provide a description of the methods that were used in this study. This chapter includes the purpose of the study, research questions, research design, information on the recruitment of participants and distribution of surveys, details of the instruments, methodological assumptions, and ethical considerations.

### Study

#### *Purpose and Research Questions*

The purpose of the study is to examine Primary/Junior/Intermediate (JK-8) pre-service teacher candidates' mindsets and self-efficacy in teaching science in the first year of the two year B.Ed program at the University of Windsor. The following research questions frame this study:

- 4) How is self-efficacy related to mindset? – Comparing mindset and self-efficacy survey responses provides insight into whether there is a relationship between self-efficacy and mindset.

#### **Hypotheses:**

H<sub>O</sub>: Self-efficacy is not related to mindset; or

H<sub>A</sub>:

- a. Teacher candidates with high self-efficacy show a GM; and/or
  - b. Teacher candidates with low self-efficacy show a FM; and/or
  - c. Teacher candidates with high self-efficacy show a FM; and/or
  - d. Teacher candidates with low self-efficacy show a GM.
- 5) Does the first year of the new two-year B.Ed program affect the self-efficacy of elementary teacher candidates? – Analyzing the pre- and post-survey results

provides insight into whether the first year of the B.Ed program influences elementary pre-service self-efficacy.

**Hypotheses:**

H<sub>0</sub>: There is no significant difference in self-efficacy and mindset in teacher candidates over the first year in the new B.Ed program; or

H<sub>A</sub>:

- a. There is a significant increase in self-efficacy and mindset in teacher candidates over the first year; or
- b. There is a significant decrease in self-efficacy and mindset in teacher candidates over the first year.

- 6) What are pre-service teachers' thoughts on how their mindset and self-efficacy affects their science teaching? – Results from the questionnaire demonstrate elementary teacher candidates' understandings of their mindset and self-efficacy. This metacognitive reflection practice is important because it provides insight into problems that elementary teachers face in teaching science.

***Research Design***

In this study, I used a multi-methods, overall descripto-explanatory (Saunders, Lewis & Thornhill, 2007) research approach to explain the problem that some elementary teacher candidates face when teaching science, in the context of mindset and self-efficacy.

This study takes on a multi-methods research design because I have multiple data sets to offer an explanation to the same research questions (quantitatively: SEMSurvey, and qualitatively: SEMQuestionnaire). I distinguished this research as a multi-methods

approach because two research methods were used to answer the research questions; a quantitative descriptive research approach was used to identify the self-efficacy and mindsets of the participants, and a triangulated qualitative-quantitative explanatory comparative cross-methods research approach was used to compare the differences in self-efficacy and mindset in participants over the first year of the B.Ed program.

An advantage of using the multi-method approach is that it provides a diverse range of data that are able to be compared via triangulated cross-method comparisons (Brewer, & Hunter, 2006). Initially, I explained how this study began as an exploratory research approach, where I used the data to define the mindset and self-efficacy teacher candidates were showing. Interdependence is assumed between the mindset section of the SEMSurvey, the self-efficacy section of the SEMSurvey, and the SEMQuestionnaire. The rationale of linking the different data sets is to test Bandura and Wood's (1989) model, using refined versions of quantitative and qualitative data collection methods (Brewer, & Hunter, 2006). This may be a problem in the study because it does not replicate the model (Bandura & Wood, 1989) exactly, but it does take into consideration the problems with each instrument and it applies the suggested modifications. Although my study uses different instruments, my results will show whether Bandura and Wood's 1989 findings are validated.

### *Selecting Participants*

In the Ontario education system, there are general requirements for each Faculty of Education to follow. The University of Windsor's Faculty of Education uses the following guidelines for placing teacher candidates in their divisions: Primary/Junior (P/J) - Junior Kindergarten to Grade 6, Junior/Intermediate (J/I) - Grade 4 to 10, or

Intermediate/Senior (I/S) - Grade 7 to 12. P/J does not have a teachable subject; J/I division requires one teachable subject; I/S requires two teachable subjects.

Senior division (I/S) teacher candidates are placed in a secondary school setting where they are able to perform in their qualified-teachable subject(s). Educators, teaching in their qualified-teachable subjects, show direct correlations with student achievement in that subject; a teacher qualified in science tends to produce students with higher science achievements (Darling-Hammond, 2000) than an English-qualified teacher teaching science, for example.

P/J/I teacher candidates practice in an elementary school that generally requires them to teach all subjects. Elementary educators often experience self-efficacy issues in teaching subjects that they are unfamiliar with, whereas secondary teachers do not have this issue because they teach their specialized topic (Kazempour, 2014).

Through purposeful sampling, P/J and J/I division pre-service teachers were the active participants in this study because they are expected to teach all subjects across the curriculum, including science, even if it is not their specialty.

In the fall semester of 2015, I set out to gather participants for my pre- and post-survey portion of my project. I was hoping to have the participants take my survey before their first practicum experience, which began on October 19 and ended on October 30; however, REB approval was pending. Luckily, the first practicum experience was only an observational experience, and pre-service teacher candidates did not have the chance to actively teach and thus were not able to truly assess their self-efficacy in teaching for the survey in October practicum. Given the minor delays with the REB application, my research was postponed until November 23. I was granted REB approval on November

23, 2015 which was when they began their second practicum. Pre-service teacher candidates attended their first day of practicum, which is generally an observation day, and the pre-survey was released the day after, on November 24.

I obtained permission to send prospective P/J/I participants invitations to participate in my study (Appendix A). The pre-survey invitation was electronically sent to the secretary of the Associate Dean of pre-service education. The secretary acted as a liaison between myself and the prospective participants because I was not able to directly email the pre-service teacher candidates as a means to respect their confidentiality. The secretary obtained all emails of the P/J/I pre-service teacher candidates and electronically forwarded the invitation with the link to them and an informative letter regarding my study (Appendix B). The link directed the participants to the online survey platform, SurveyMonkey™, where the survey was set up for them to voluntarily complete during that second practicum in November. Of the 89 pre-service P/J/I teacher candidates enrolled in the new two-year B.Ed program, 56 voluntarily participated in the pre-survey portion of the study.

Similarly, the post-survey was sent electronically for voluntary participation via the secretary. Of the 56 participants in the pre-survey, only 44 voluntarily participated in the post-survey of the study. The post-survey was released on April 1, 2016, and final data for the survey was collected on April 15, 2016.

Quantitative data was collected and analyzed for any correlation between the mindset and self-efficacy tests. Analysis was also conducted to determine if the first year of the B.Ed program changed participants' mindsets or self-efficacy.

Similarly, the questionnaire was electronically sent out to the P/J/I pre-service teacher candidates on April 1, 2016. Four responses were collected, with the final response collected on April 21, 2016. Qualitative data was collected and used as a descriptive element in supporting the reasoning behind the quantitative results.

### *Instrumentation*

A quantitative pre- and post- survey and a qualitative questionnaire were utilized in this study. The quantitative survey, entitled “Self-Efficacy and Mindset Survey,” will be herein referred to as “SEMSurvey.” The Survey is made up of three sections: Mindset, Self-Efficacy, and Demographics. Mindset of the pre-service elementary teacher candidates were assessed using the General Implicit Theories of Intelligence Scale [ITIS] (Dweck, 1999). Self-efficacy of the pre-service elementary teacher candidates was measured using the Personal Science Teaching Efficacy [PSTE] section of the Science Teaching Efficacy Belief Instrument form B [STEBI-B] (Enochs and Riggs, 1990).

The qualitative questionnaire, entitled “Self-Efficacy and Mindset Questionnaire,” will be herein referred to as “SEMQuestionnaire.” The qualitative measure follows the construct of self-report questionnaires (Dinsmore, Alexander & Loughlin, 2008), and was used in a study about self-regulated learning (Cleary, Callan, Malatesta & Adams, 2015). It involves a series of statements asking about beliefs, attitudes, or behaviours that generate retrospective responses. In the current study, reflective responses from this questionnaire are used in conjunction with the quantitative data to make inferences about self-efficacy and mindset in pre-service teacher candidates.

### *Measuring Self-Efficacy using the STEBI-B*

Enochs and Riggs (1990) developed the STEBI-B (Science Teaching Efficacy Belief Instrument form B) to quantitatively measure the self-efficacy of pre-service teachers teaching science through two categories: Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE). According to Enoch and Riggs (1990), the STEBI-B survey's reliability is based on a sample size of 212 pre-service elementary teachers; Cronbach's alpha coefficient for the PSTE category is 0.90 and for STOE the coefficient is 0.76. Studies conducted after Enoch and Riggs' initial development of the STEBI-B instrument utilized smaller sample sizes with a minimum of 29, where Cronbach's reliability coefficients were all above the described standard (0.70) for being a reliable test (Bergman & Morpew, 2015; Bleicher, 2010; Cakiroglu & Boone, 2005; El-Deghaidy, 2006; Sanguenza, 2010); the methods that each study used all showed statistical reliabilities (Mendenhall, Beaver, Beaver & Ahmed, 2009).

The original STEBI-B consists of 23-statements that are rated by the participants on a five-point Likert scale, ranging from Strongly Disagree to Strongly Agree. The 23 items on the survey are broken into two subscales; one set of 13 (See Appendix C. Original STEBI-B-letters b, c, e, f, h, l, q, r, s, t, u, v, w) statements that measure Personal Science Teaching Efficacy (PSTE) and the other is a set of 10 (See Appendix C. Original STEBI-B-letters a, d, g, i, j, k, m, n, o, p) statements that measure Science Teaching Outcome Expectancy (STOE).

In the STEBI-B, there are two categories that measure different attributes of teaching: Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE). By utilizing both concepts of self-efficacy, researchers can better

predict behaviour. However, according to Bandura (1977), self-efficacy expectations are the most powerful determinants of behavioural change because they influence the initial decision to perform the behaviour, the effort required, and the ability to persist through adversity. The STOE is not as powerful a determinant as PSTE.

Enochs and Riggs (1990) determined that STOE is slightly less reliable than the PSTE, which is consistent with similar findings from the *TES* by Gibson and Dembo (1984). There are a number of reported discrepancies between PSTE and STOE results, more specifically, the discrepancy between PSTE and STOE scores and the participants' years of schooling in science from Grade 9 and on (Enochs and Riggs, 1990). This discrepancy is important because if the PSTE shows a positive correlation with years of science education and the STOE does not show a similar correlation, results between the two sections of the STEBI-B may be inconsistent. Another discrepancy is described by Borchers and colleagues (1992) who observed that STOE is not related to changing teacher behaviours, whereas PSTE shows a positive correlation. For these reasons, I utilized only the PSTE category to assess the participants' self-efficacy. Furthermore, if I were to use STOE data, for it to be meaningful, I would need to compare it to participants' actual performance, that is, I would need to obtain and analyze their official performance results or their teacher evaluation reports and relate them to their STOE responses. Official results will not be used because firstly, official performance results are confidential per the Faculty of Education policies and secondly, this study is meant to be more of a reflective study involving only the participants' perceptions of their performance.



I have, therefore, modified the STEBI-B to exclude the STOE items because it measures self-efficacy using only the PSTE portion of the STEBI-B. Additionally, I have modified the rating scale from a 5-point Likert to a 6-point Likert as to reduce the risks that may be causing deviations from decision making (Chomeya, 2010) and to ease the participants' survey-taking experience so that they do not get confused between the scale differences as they switch from the mindset test to the STEBI-B. Another reason to use 6-point Likert scales is that their reliability values tend to be higher than on 5-point Likert scales (Chomeya, 2010).

STEBI-B PSTE statements are measured on an ordinal rating scale that ranges from 1-Strongly Disagree to 6-Strongly Agree. As in Enochs and Riggs' (1990) survey analysis, negatively worded items are scored in the opposite direction (reverse scoring as described by Boone, Staver & Yale, 2015) - implying that a score of 1 (strongly disagree) on a negatively worded items, such as "I will find it difficult to explain to students why science experiments work," will receive a score of 6 because disagreeing with that negative statement is representative of a high self-efficacious teacher. Because I have modified the rating scale and am using only the PSTE, I have also altered the overall points system. Scores of the PSTE statement responses will be tallied, each participant receiving a score between 13 and 78; higher scores infer higher levels of self-efficacy; lower scores infer lower levels of self-efficacy. By simply splitting the range into two, I classified the low self-efficacy division ranging from a score of 13 to 44, and the high self-efficacy division ranging from a score of 45 to 78.

### *Measuring Mindset using the General ITIS*

Dweck (1999) developed the General Implicit Theories of Intelligence Scale (ITIS) to measure the implicit theory of participants (Appendix D). According to Hong, Chiu, Dweck, Lin and Wan (1999) the general ITIS's validity is based on three sample sizes ranging from 32 to 148, producing reliability coefficients ranging from 0.94 to 0.98. Studies using this scale with sample sizes of a minimum of 33 participants showed reliability coefficients of above 0.82 (Garcia & McCoach, 2009; Jones, Bryant, Snyder & Malone, 2012). The scale is unaffected by various potentially confounding variables, such as social desirability, intellectual ability, and self-presentation concerns, which support the validity of the scale. This scale is known as the General ITIS because it is argued that the "you" statements may idealize the participants' general implicit theories, which may not be about their own abilities (DeCastella & Byrne, 2015).

The ITIS explores the pre-service teachers' mindset by having them rate eight statements related to their implicit theories of intelligence (Dweck, 1999). It contains four incremental statements that are indicative of a growth mindset (E.g. "You can always greatly change how intelligent you are"), and four entity theory items that are indicative of a fixed mindset (E.g. "You have a certain amount of intelligence and you can't do much to change it"). (See Appendix D. General ITIS - statements 1, 2, 3, and 6 are based on entity theory; statements 4, 5, 7, and 8 are based on incremental theory). The statements were worded so that "you" was utilized as a way to initiate the participants' metacognition. Items were rated on a 6-pt Likert scale, with 1-Strongly Disagree and 6-Strongly Agree.

Similar to the negatively worded items in STEBI-B, answers to the entity theory questions will be reverse scored. Scores of the questionnaire will be tallied, each participant receiving a score between 8 and 48 (Dweck, 1999); higher scores suggest that the participant possesses more incremental/growth mindset qualities; lower scores suggest that the participant possesses more entity/fixed mindset qualities. A GM score ranges from a total score of 29 to 48, while the FM ranges from a total score of 8 to 28. According to Dweck (1995), an individual's mean score of 3 or lower is representative of an entity theorist, and an individual's mean item score of 4 and above are classified as incremental theorists. Those with mean item scores in between 3 and 4 are unclassified and are excluded from data.

### ***Demographics***

The individual STEBI-B, ITIS and demographics items are compiled into a one-link survey to simplify the process for the participants. See Appendix E: Self-Efficacy and Mindset Survey (SEMSurvey). The demographics section is found at the end of the SEMSurvey (pre- and post-). All participants complete the demographics section, thereby creating a profile for themselves and a self-generated identification code that maintains the participants' anonymity but allows the correlation of pre- and post- data. The demographics section collects qualitative data to develop a profile that contains information on gender, age group, ethnicity, teachable, and science education background.

### ***Reliability of SEMSurvey***

The reliability of the SEMSurvey was calculated in SPSS using Cronbach's Reliability Coefficient for both mindset and self-efficacy sections of the SEMSurvey.

The mindset section of the SEMSurvey showed  $\alpha = 0.836$ ,  $N=32$ . This value is over the standard 0.70 value for the test to be reliable. This value is also in alignment with the General ITIS reliability statistics;  $\alpha = 0.82$ ,  $N=33$  (Garcia & McCoach, 2009; Jones, Bryant, Snyder & Malone, 2012), and  $\alpha = 0.94-0.98$ ,  $N=32-148$  (Hong, Chiu, Dweck, Lin & Wan, 1999).

The self-efficacy section of the SEMSurvey showed  $\alpha = 0.897$ ,  $N=32$ . This value is over the standard 0.70 value for being reliable. This value is also in alignment with the STEBI-B, PSTE reliability statistics;  $\alpha = 0.90$ ,  $N=212$  (Enochs & Riggs, 1990), and  $\alpha > 0.70$ ,  $N=29$  (Sanguenza, 2010; El-Deghaidy, 2006; Bleicher, 2010; Cakiroglu & Boone, 2005; Bergman & Morpew, 2015).

### ***Questionnaire***

I have developed the SEMQuestionnaire to address further inquiries regarding self-efficacy and mindset in elementary pre-service teacher candidates. This questionnaire collects descriptive data (See Appendix F). The invitation for P/J/I pre-service teacher candidates to participate in the questionnaire was electronically sent via the secretary of the Associate Dean on April 1, 2016.

### ***Ethical Considerations***

Research Ethics Board approved this study and granted the permission to distribute the testing materials and the questionnaire to the participants. Pre-service teacher candidates' values and opinions are respected and as mentioned in Appendix B, if at any time they did not feel comfortable, they could leave the study at any time.

## CHAPTER 4: DATA COLLECTION AND ANALYSIS

### *Introduction*

In this chapter, I will briefly describe the collection of data and my thought process in analyzing the data to address the research questions. The three original research questions and methods of analysis are summarized in Table 1. An additional inquisitive question was included for further exploration of that data.

Table 1

### *Research Questions, Data Sources, and Data Analysis*

Research Question	Data Sources	Data Analysis
Is self-efficacy related to mindset? How?	Pre- and post-survey data	-Pairing data from pre- and post-survey data. -Descriptive statistics of pre- and post-Mindset and STEBI data. -Correlational analysis of pre-Mindset data with pre-STEBI data. -Correlational analysis of post-Mindset data with post-STEBI data.
a) Does the first year of the new two-year B.Ed program affect the self-efficacy of elementary teacher candidates?	Pre- and post-survey data	a) Compare overall means of the pre- and post-STEBI data.
b) Does the first year of the new two-year B.Ed program affect the mindset of elementary teacher candidates?		b) Compare overall means of the pre- and post-Mindset data.
What are pre-service teachers' thoughts on how their mindset and self-efficacy affects their science teaching?	Questionnaire and Pre- and post-survey data	-Cross-case analysis of qualitative questionnaire responses. -Questionnaire data and survey data are triangulated within participants for explanatory purposes.
*Do factors other than the first year of the B.Ed program affect	Pre-survey data	-ANOVA

the self-efficacy and/or mindset  
of the participants?  
-Gender?  
-Teaching division?  
-Last time studying science?

---

**Data Collection**

The following data presented are collected from the pre- and post-SEMSurvey and the SEMQuestionnaire.

***SEMSurvey***

The SEMSurvey data are arranged in two separate tables for organizational purposes. Section one (Mindset) and two (Self-Efficacy) data of the pre- and post-SEMSurvey are displayed in Table 2. Data from the third section (Demographics) of the SEMSurvey are arranged in Table 3.

Of the 89 pre-service P/J/I teacher candidates enrolled in the new 2 year B.Ed program, 56 voluntarily participated in the pre-SEMSurvey portion of the study, which was released in the fall term. Of those 56 participants in the pre-SEMSurvey, only 44 voluntarily participated in the post-SEMSurvey of the study. The post-survey was released at the end of spring and final data for the survey was collected within a two week period. Descriptive statistics for self-efficacy and mindset of the sample can be viewed in Table 2. The self-efficacy portion and the mindset portion of the SEMSurvey were separately scored because they are treated as two individual concepts.

Table 2  
*Elementary Pre-service Teachers' SEMSurvey Item Means*

	Pre-Mindset (N=56)			Post-Mindset (N=44)		
Mindset Items	<i>M</i>	<i>SD</i>	<i>M<sub>weighted</sub></i>	<i>M</i>	<i>SD</i>	<i>M<sub>weighted</sub></i>

1.	You have a certain amount of intelligence, and you can't really do much to change it.	2.05	0.99	4.95	2.07	0.99	4.93
2.	Your intelligence is something about you that you can't change very much.	1.89	0.67	5.11	1.98	0.99	5.02
3.	No matter who you are, you can significantly change your intelligence level.	4.82	0.93	4.82	5.02	0.81	5.02
4.	To be honest, you can't really change how intelligent you are.	1.84	0.68	5.16	1.93	0.78	5.07
5.	You can always substantially change how intelligent you are.	4.71	0.92	4.71	4.80	0.76	4.80
6.	You can learn new things, but you can't really change your basic intelligence.	2.88	1.23	4.13	2.64	1.17	4.36
7.	No matter how much intelligence you have, you can always change it quite a bit.	4.70	0.78	4.70	4.68	0.85	4.68
8.	You can change even your basic intelligence level considerably.	4.55	1.02	4.55	4.64	0.91	4.64
Total average		3.43	0.90	4.77	3.47	0.91	4.82

Self-efficacy Items	Pre-Self-Efficacy ( <i>N</i> =56)			Post-Self-Efficacy ( <i>N</i> =44)			
	<i>M</i>	<i>SD</i>	<i>M</i> <sub>weighted</sub>	<i>M</i>	<i>SD</i>	<i>M</i> <sub>weighted</sub>	
9.	I will continually find better ways to teach science.	5.23	0.57	5.23	5.18	0.53	5.18
10.	Even if I try very hard, I will not teach science as well as I will most subjects.	2.39	1.11	4.61	2.68	1.36	4.32
11.	I know the steps necessary to teach science concepts effectively.	3.57	1.50	3.57	3.98	1.42	3.98
12.	I will not be very effective in monitoring science experiments.	2.41	1.10	4.59	2.18	0.89	4.82
13.	I will generally teach science ineffectively.	2.16	0.92	4.84	2.25	1.00	4.75
14.	I understand science concepts well enough to be effective in teaching science.	4.07	1.31	4.07	4.39	1.15	4.39
15.	I will find it difficult to explain to students why science experiments work.	2.88	1.24	4.13	3.00	1.17	4.00
16.	I will typically be able to answer students' science questions.	4.20	1.11	4.20	4.43	1.01	4.43
17.	I wonder if I will have the necessary skills to teach science.	4.14	1.33	2.86	3.61	1.45	3.39
18.	Given a choice, I will not invite the principal to evaluate my science teaching.	3.75	1.50	3.25	3.52	1.47	3.48
19.	When a student has difficulty understanding a science concept, I will usually be at a loss as to	2.66	1.18	4.34	2.61	1.13	4.39

	how to help the student understand it better.						
20.	When teaching science, I will usually welcome student questions.	5.07	0.90	5.07	5.20	0.76	5.20
21.	I do not know what to do to turn students on to science.	2.73	1.22	4.27	2.84	1.30	4.16
Total average		3.48	1.15	4.23	3.53	1.13	4.35

*Note.* Mindset and Self-Efficacy data as part one and two of the three part SEMSurvey.

Means ( $M$ ), standard deviations ( $SD$ ), and weighted means ( $M_{weighted}$ ) for the Mindset items and the Self-Efficacy items in the pre- and post-SEMSurvey were calculated (Table 2).  $M_{weighted}$  describes the mean response to the statement with respect to the scoring and reverse scoring procedures as outlined in the *Chapter 4: Instrumentation*.

For the Mindset items, weighted means higher than 3.0 are interpreted as an incremental/growth mindset, while weighted means lower than 3.0 are interpreted as an entity/fixed mindset. Raw data findings suggest that the average pre-Mindset score per individual item is 4.77, suggesting a growth mindset. Post-Mindset score per individual item is 4.82, suggesting a slightly stronger growth mindset than the pre-Mindset data.

Likewise, for the Self-Efficacy items, weighted means higher than 3.0 are categorized as a high level of self-efficacy, whereas weighted means lower than 3.0 are categorized in to a low level of self-efficacy. Raw data findings suggest that the average pre-Self-Efficacy score per individual item is 4.23, suggesting a high self-efficacy. Post-Self-Efficacy score per individual item is 4.35, suggesting a slightly higher self-efficacy than the pre-Self-Efficacy data.

Values of significance were not found for these raw-data findings, as they could not be compared properly due to differences in sample sizes. As displayed next in *Chapter 4: Data Analysis*, I paired the data and analyzed the overall scores of the



Mindset section and the Self-Efficacy section of the SEMSurvey, in order to better compare the findings and make statistical sense of the data.

Raw data for demographics section of the pre- and post-SEMSurvey samples showed that  $\frac{3}{4}$  of participants were female, and  $\frac{3}{4}$  were in the age range of 21-25. With regards to teachables, pre-SEMSurvey data showed that 20/56 teacher candidates were P/J, and the remainder had one teachable subject in the J/I division. Post-SEMSurvey data showed that 17/44 teacher candidates were P/J, and the remainder were J/I. No teacher candidates possessed Physics as a teachable, and only 1 from each survey possessed Chemistry, while less than 2 possessed Biology as a teachable. The majority of the participants' last time studying science was in high school, while 9 participants from both pre- and post-SEMSurvey noted that their last time studying science was in their 4<sup>th</sup> year of university. This data is useful for ensuring that self-generated codes matched in pairing the data, and it will be used for further analysis as outlined in the next section of *Chapter 4: Data Analysis*.

### ***SEMQuestionnaire***

Similarly, the questionnaire was electronically sent out to the P/J/I pre-service teacher candidates on April 1, 2016. Only four responses were collected, with the final response collected on April 21, 2016. Table 3 provides the responses to the questionnaire. This qualitative data is used as a descriptive element in supporting quantitative results.

Table 3  
*SEMQuestionnaire Responses*

<b>Responses to Respective Questions</b>	
<b>Respondent</b>	<b>Q1: Enter the Last letter of mother's name; Age of mother; First letter of your name; Year of father's birth (yy); Last letter of father's name. (x / ## / x / ## / x)</b>
A	Y54T60Y
B	Y/63/s/47/1
C	B/57/J/48/S

D R50S68E

**Q2: What grade(s) did you teach?**

- A Grade 1 and 3/4 split
- B 2 3 4
- C 4 - JK/SK
- D Grade 5 homeroom and grade 4-8 FSL

**Q3: What subject in science did you teach?**

- A Pulleys, gears and structures
- B N/a
- C Habitats for my grade 4s and Dinosaurs and Fossils for JK/SK
- D None

**Q4: How did you find the level of difficulty when teaching science?**

- A i found it difficult because we have not had science methodology yet
- B I did not feel comfortable teaching science in my practicum as we did not have methodology this year.
- C For the grade 4s it was really difficult to incorporate the curriculum to their interests to engage them.
- D NA

**Q5: How did you feel while teaching science?**

- A I was a little unsure of myself
- B N/a
- C I did not mind teaching science, I just wish I had been more prepared to make it a better experience for my students.
- D NA

**Q6: To what degree was science challenging? Please elaborate.**

- A literally having no methodology made it challenging. i had no idea what to do besides use pinterest
- B I have always struggled with science.
- C I think it was challenging because I personally don't have a science background. This, on top of no science methodologies at th faculty, had hindered my ideas about science going into the classroom. I have mild science knowledge but wanted to be sure I was always giving correct answers and accurate information.
- D NA

**Q7: Rate your childhood science-learning experience. What impact did that have in further studies in science?**

- A on a scale of 1-10 , 10 being great, i'd say 5. it was not a subject i had much interest in. i only took what i needed to
- B I hated science.
- C My childhood science learning experience was okay, I just was not super interested in science. This led me to not pay attention and not take extra science classes in highschool. I turned to social science the second I had the chance and never looked back. Now I have great social science knowledge but find myself regretting not staying up to date with the other sciences.
- D I enjoyed science, and I decided to continue taking physics in grade 11. However, my physics teacher and I did not get along and science courses were just lowing my average for university entrance scholarships, so I stopped taking them.

**Q8: What do you think affects student learning?**

- A i think engaging lessons has the most impact. students will be more excited to learn if the teacher seems excited
- B Teacher attitude towards subject
- C I think students need to always be engaged. This can be with the teacher or other students but they need to interested. If they are not, your job as a teacher is to intrigue them so they are interested. In addition, teacher-student rapport affects students learning. Being cold and standoffish will not give your students the learning environment that they need, it will keep them quiet and distant.
- D The enthusiasm of the teacher has a big impact, as well as the enthusiasm, values and knowledge of the parents.

**Q9: How does mindset affect you?**

- A its hard to be engaging when you don't know the material or how to teach it
- B We as teachers need to have positive mindsets if our students are going to learn.
- C I think mindset affects me because having a positive mindset is what keeps you going. Even though I bombed a few lessons, or retaught a few lessons during my placement, I had a good mindset that things would get better. And they did. It's a strong part of a persons personality and can determine a lot about a person.

D I always try to teach with enthusiasm, regardless of my own interest in the subject matter, because I want my students to learn effectively and enjoy learning.

**Q10: To what degree does your mindset affect your students?**

A i think they have less confidence and interest in someone that they see is struggling to teach

B I think 100% affects our student.

C I think my mindset affects my students to a great degree. How I feel will be picked up by them and they will then feel the same. Negativity will spread like a wildfire. Always being positive and at least attempting to have the best mindset possible is the best for your students.

D My opinions on a subject can affect how students feel about that subject

**Q11: How does self-efficacy affect you?**

A i was able to research the topics and find resources to help me feel more confident or look more confident teaching science

B I Stan duo for what I believe in, and stand up when someone has done something wrong.

C Self-efficacy affects me because it's like my drive. The "thing" inside me that keeps me going and keeps pushing me to accomplish what I want to accomplish. It makes me want to reach my goals and set more each day.

D I need to feel confident in my abilities to teach the subject matter and to perform the tasks myself before I can ask that of my students

**Q12: To what degree does your self-efficacy affect your students?**

A this allowed me to come off as being knowledgeable in the area, and the students trusted me to teach them

B Our students have learned self helplessness.

C I think my self efficacy affects my students because they see the strive that I am taking to better my future. This is especially true when I was in placement with the grade 4's because they had so many questions about high school and university and as they asked me, I answered. Seeing there eyes widen when I said I had 11 classes on top of coming and teaching them, they then noticed that drive is something you need. I remember telling all of them students that it doesn't matter what you want to be, trying your best and believing in yourself will get you there.

D Students need to see that I am confident and understand the subject matter, but also that I am not afraid to say "I do not know; let's find out".

**Q13: What was the factor that influenced your teaching the most in the first year of the B.Ed program?**

A Not having methodology in more than half of the subjects we were expected to teach

B My second associate.

C The factor that influenced your teaching the most in my first year was my mentors. I am in contact with many old teachers and always conversed with them about different ideas. Most of the time they had tried some and could give me some great pointers. I think having this support was the best. In addition, having the professors at the faculty who all were more than open to questions and comments during practicum.

D Learning how to teach every subject with enthusiasm

---

*Note.* Responses are copied exactly as participants entered them.

### *Data Analysis*

Parametric tests are ideal for the SEMSurvey quantitative data because they are continuous and interval. Non-parametric tests can and are used for some analyses in this section, but these tests tend to have less power than parametric tests. Note: Throughout this analysis section, unless otherwise stated in a test, the null hypothesis is rejected when the  $p$ -value is less than 0.05.

### *Analysis of Quantitative Data*

*RQ1*) To determine whether there is a significant relationship between mindset and self-efficacy, I paired the data and analyzed the overall scores of the Mindset section and the Self-Efficacy section of both the pre- and the post-SEMSurveys. Then I conducted normality tests and correlation tests.

I exported the pre- and post- data sets from SurveyMonkey in to SPSS. I used SPSS to sort, pair, and analyze the data sets. Pairing data required matching participants' self-generated codes. Considering that there were fifty-six pre-SEMSurvey participants and only forty-four took the post-SEMSurvey, there could have been a possible forty-four data pairs. Of the possible forty-four pairs, thirty-two self-generated codes were matched (Table 4), and these pre- and post-SEMSurvey overall Mindset and Self-Efficacy scores were paired for further statistical analysis. As mentioned in *Chapter 3: Instrumentation*, scores of mindset are categorized into either a GM (29-48) or a FM (8-28), and scores of self-efficacy are categorized into either a High Self-Efficacy (45-78) or a Low Self-Efficacy (13-44). Average pre-SEMSurvey paired data show an average GM ( $M=38.16$ ,  $SD=4.95$ ) and an average High Self-Efficacy ( $M=56.59$ ,  $SD=9.75$ ). Average post-SEMSurvey paired data also show an average GM ( $M=38.28$ ,  $SD=5.59$ ) and an average High Self-Efficacy ( $M=57.28$ ,  $SD=10.30$ ).

Table 4  
*Paired SEMSurvey Scores*

Code	Pre-Mindset	Post-Mindset	Pre-Self-Efficacy	Post-Self-Efficacy
A/45/A/43/R	38	40	63	65
A/52/E/63/N	40	41	49	52
A/57/M/57/W	36	38	49	63
A/61/K/52/N	32	36	46	60
A/51/C/55/T	39	37	61	58
A/52/A/61/R	40	40	53	<b>31</b>
A/55/K/63/N	44	41	73	74
D/00/X/00/X	38	42	50	63

E/47/J/64/O	40	38	<b>43</b>	45
E/49/A/63/O	44	31	67	52
E/53/A/62/C	40	40	59	50
E/55/M/55/B	41	48	46	55
E/58/C/55/N	42	42	61	67
H/53/R/63/N	36	35	56	51
L/67/T/40/N	33	38	<b>39</b>	<b>38</b>
N/51/A/63/Y	<b>26</b>	40	54	64
N/55/E/61/U	45	<b>28</b>	69	45
R/50/S/68/E	37	36	65	61
T/56/J/57/R	40	48	50	71
Y/50/B/60/L	39	39	49	59
Y/54/T/60/Y	40	47	<b>41</b>	48
Y/54/M/63/R	32	37	52	45
Y/55/T/61/I	47	47	64	63
Y/62/A/50/M	33	39	51	53
Y/62/S/49/X	41	41	68	53
A/50/K/63/Y	40	40	65	64
A/51/S/63/L	34	<b>26</b>	60	65
B/57/R/47/N	43	30	69	52
E/57/J/57/M	40	40	78	77
J/49/S/66/T	42	38	59	64
N/50/F/63/Y	27	36	48	56
X/00/X/00/X	32	<b>26</b>	54	69
<i>M</i>	38.16	38.28	56.59	57.28
<i>SD</i>	4.95	5.59	9.75	10.30

*Note.* Participant pre-survey data paired with their post-survey data. Thirty-two sets of data were paired.  $N=32$ . Bolded data are representative of either a Fixed Mindset score or a Low Self-Efficacy score.

I did run in to an issue regarding the self-generated coding formula. The coding formula was “Enter the last letter of your mother’s name; Age of your mother; First letter of your name; Year of your father’s birth (yy); Last letter of your father’s name.” This coding formula caused some confusion in pairing the participants because the “Age of your mother” variable may have changed for some participants because their mothers may have had a birthday over the scope of the study (November 24, 2015 to April 15, 2016). This did complicate the pairing of pre- and post-SEMSurvey participants; however, in these cases, demographics were utilized as a backup method of pairing. Of those participants whose self-generated codes varied by the “Age of your mother” variable, their demographics matched. Another issue arose when some participants did not enter a self-generated identification code at all. These participants results were not

utilized in the analysis because they could not be matched in their pre- and post- SEMSurveys. There was one participant who entered a semi-completed self-generated code (x/00/x/00/x); that is, they chose only to include the letters in the coding sequence and ignored that numbers (age of mother and year of father’s birth). The participant may not have chosen to enter the numbers in the coding sequence because they were unsure. However, this participant was included in the analysis because it had an identical match based on demographics and the letters in the coding sequence.

To determine if mindset and self-efficacy are related, I first needed to determine if the scores from the paired pre- and post-SEMSurvey displayed a normal distribution.

Then I could decide which correlation test I could use. According to the Figure 4,

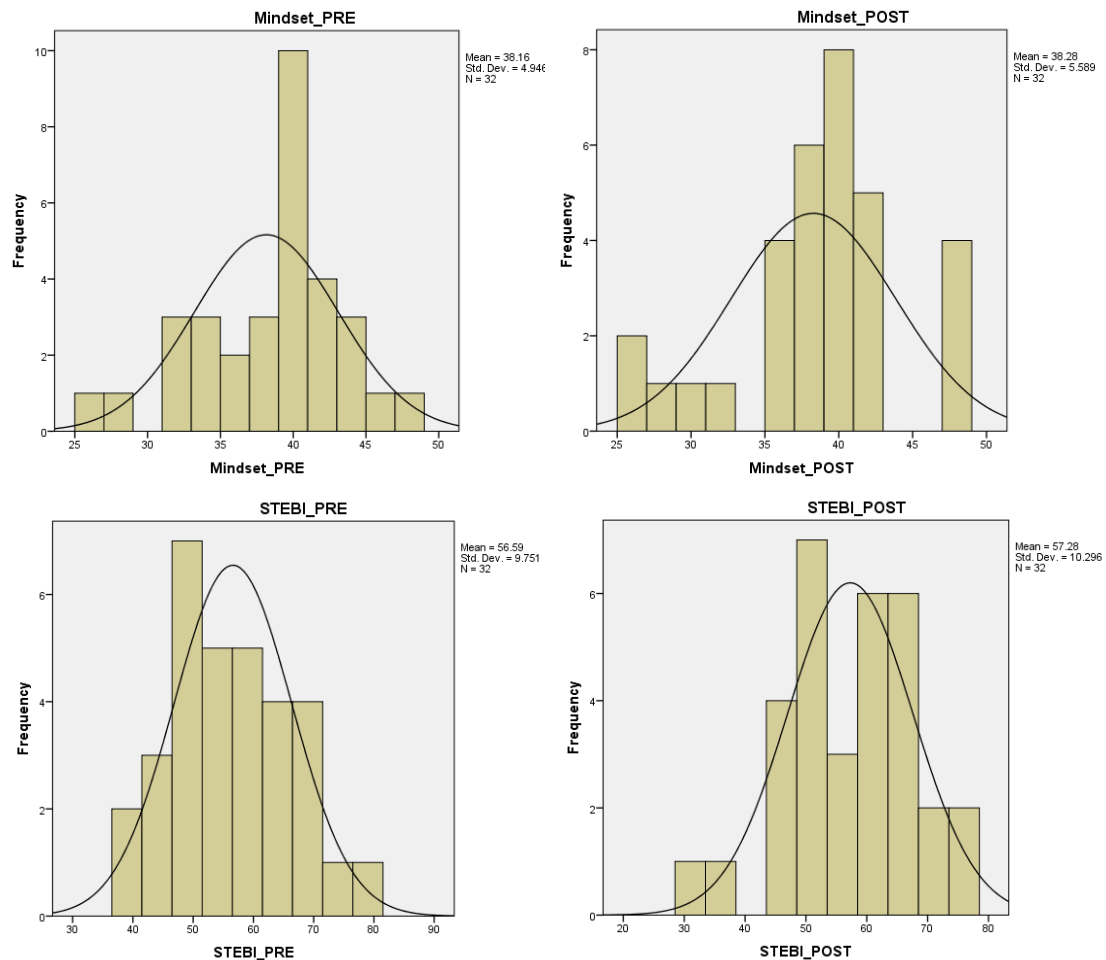


Figure 4. Normally Distributions of Paired Data from SEMSurvey

visually, the pre- and post-Mindset and Self-Efficacy data show fairly normal distributions. However, visual inspection is not a strong enough factor to decide whether data is normally distributed.

When the Skewness and Kurtosis values are considered, they show that the samples do not represent a perfectly normal distribution because their values are not 0. A simple calculation to test for normality is to divide Skewness or Kurtosis values by their respective *Standard Error (SE)* values; if these values are within  $\pm 1.96$  limits, it suggests the departure from normality is not very extreme (Mendenhall et al., 2009). With regards to this data, departure from normality is not extreme. Table 5 shows these values as well as the statistical Shapiro-Wilk Test of normality.

Statistically, normality was tested using the Shapiro-Wilk Test. According to Table 5, based on the Shapiro-Wilk Test, all data shows a normal distribution (where the *p*-values are all greater than 0.05) except for the post-SEMSurvey Mindset data, which shows a non-normal distribution with a *p*-value of 0.029. This statistic indicates that the sample data for Self-Efficacy are not significantly different than that of a normal population, but that the sample data for Mindset are significantly different than that of a normal population.

Table 5  
*Normality of Self-Efficacy and Mindset Paired Data from SEMSurvey*

	<i>Skewness</i> ( <i>SE</i> =0.414)	<i>S/SE</i> =	<i>Kurtosis</i> ( <i>SE</i> =0.809)	<i>K/SE</i> =	Shapiro-Wilk Test		
					<i>Statistic</i>	<i>df</i>	<i>p</i>
Pre-Mindset	-0.716	-1.73	0.302	0.396	0.942	32	0.088
Post-Mindset	-0.486	-1.17	0.473	0.585	0.925	32	0.029
Pre-Efficacy	0.213	0.514	-0.675	-0.834	0.977	32	0.720
Post-Efficacy	-0.410	-0.990	0.196	0.242	0.979	32	0.759

*Note.* *S*-Skewness, *K*-Kurtosis, *SE*- Standard Error. Distributions for paired data from both pre- and post-SEMSurvey. *N*=32.

Attempts were made to transform the post-SEMSurvey Mindset data, which would also need to be performed on the pre-SEMSurvey Mindset to ensure consistency amongst the set of data. However, all transformations resulted in a lesser  $p$ -value than already calculated with the untransformed post-SEMSurvey Mindset data. This posed an issue while addressing  $RQI$  because in order to determine if there is a relationship between mindset and self-efficacy, the parametric Pearson Correlation analysis requires that both variables should be normally distributed (Mendenhall et al., 2009). After realizing that it was not possible to transform the post-SEMSurvey Mindset data, to determine whether there is a relationship between mindset and self-efficacy, I conducted a non-parametric Spearman's Rho ( $r_s$ ) Correlation analysis because it doesn't require the assumption that both variables are normally distributed. Under the assumption that the data are monotonic, SPSS automatically ranked the data to conduct Spearman's Rho Correlation. In the paired data set,  $N=32$ , pre-SEMSurvey,  $r_s=0.479$ , and post-SEMSurvey  $r_s=0.093$ . Table 6 lists the results from both Spearman's Rho and the Pearson Correlations for the paired pre- and post-SEMSurvey data.

Table 6  
*Correlation of Mindset and Self-Efficacy*

	$r_s$	$r_p$
Pre-Mindset * Pre-Self-Efficacy	0.498	0.479
Post-Mindset * Post-Self-Efficacy	0.198	0.093

*Note.* Correlations analyzed on the paired SEMSurvey data ( $N=32$ ). Correlations are significant at the 0.01 level (2-tailed).  $r_s$ - Spearman's Rho Coefficient;  $r_p$ - Pearson Coefficient.

I decided to display results from both Spearman's Rho Correlation and the Pearson Correlation analyses because I will later make the assumption that all data are normal, and normal data use the Pearson Correlation which also has more power than the Spearman's Rho Correlation (Mendenhall et al., 2009). I make this assumption in regards



to *RQ2* when comparing pre- and post-SEMSurvey scores, and *RQ4* when comparing data in regards to demographics.

*RQ2*) To determine whether the first year of the new two-year B.Ed program affected the mindset and/or self-efficacy of pre-service elementary teacher candidates, using SPSS, I conducted a Repeated Measures Analysis with the paired data sets to compare the mean scores of the pre- and post-SEMSurvey (Table 7). This analysis results in statistically insignificant values of  $p=0.934$  for the difference in mean scores of pre- and post-Mindset and  $p=0.724$  for the difference in mean scores of pre- and post-Self-Efficacy.

Table 7  
*Comparison of Mean Scores from Pre- and Post-SEMSurvey*

	<i>F</i>	Mean Square	<i>p</i>
Mindset*	0.068	0.250	0.934
Self-Efficacy	0.127	7.563	0.724

*Note.* Repeated Measures Analysis results, using  $N=32$ . \*Implies a statistical inconsistency due to Post-Mindset survey results exhibiting a non-normal distribution.

Due to the non-normal distribution of post-Mindset data, I also conducted a nonparametric statistical hypothesis test, called the Wilcoxon Signed-Rank Test, to compare the pre- and post-Mindset mean scores. This result showed a  $p$ -value of 0.627.

### *Analysis of Qualitative Data*

*RQ3*) To analyze qualitative data from the SEMQuestionnaire, a cross-case analysis between the participants was conducted. The cross-case analysis compares participants' experiences in science teaching and thoughts of self-efficacy and mindset in science teaching, based on the construct of self-regulated questionnaires (Cleary, Callan, Malatesta, & Adams, 2015; Dinsmore, Alexander & Loughlin, 2008). There were four participants in the SEMQuestionnaire. In this study, reflective responses from this

questionnaire are used in conjunction with the quantitative data to make inferences about self-efficacy and mindset in some pre-service elementary teacher candidates.

These qualitative responses were first organized by reducing the information to significant statements, and then by developing a textual (what the participants experienced) and reflective (what the participants thought of their experiences) description of their first year in the B.Ed program with respect to self-efficacy and mindset. Table 3 lists the original SEMQuestionnaire responses. Here, I provide a summary of questionnaire responses, and I highlight the themes based on the highest frequency of occurrence of opinions:

Practicum teaching experience from the participants covers all grade levels of elementary school (JK-8), however, only two participants were able to teach science. It was difficult and challenging to teach science because participants did not “have a science methodology class yet.” Pre-service teachers feel “unsure” and “unprepared” in teaching science. Participants’ childhood experiences in science were not rated well. A factor that affects student learning is “engagement/enthusiasm.” Teachers need to feel “confident” and have “positive mindsets” if students are going to learn. Teacher mindset influences student feelings about the subject. Students look up to teachers who are self-efficacious. Throughout the first year of B.Ed, mentors were a main factor that influenced participants’ teaching abilities.

The reflective responses from the SEMQuestionnaire were used for the validation of quantitative SEMSurvey findings. Although this analysis is not very significant, due to the small sample size from the questionnaire that are used to account for the survey

results, I conducted this analysis in hopes to provide further insight. I linked participant codes from the SEMQuestionnaire to their SEMSurvey data. Of the four participants in the SEMQuestionnaire, only two of the respondents' self-generated identification codes could be linked to two others from the SEMSurvey. The other two participants could not be matched.

The following code, R/50/S/68/E, represented a participant who took both the SEMSurvey and the SEMQuestionnaire. Data from the SEMSurvey indicate that this individual is a 21-25 year old female, whose teachable is French. The last time she studied science was in Grade 11. She showed a Pre-Mindset score of 37, a Pre-Self-Efficacy score of 65, a Post-Mindset score of 36, and a Post-Self-Efficacy score of 61. In reference to Table 4, she did not have an opportunity to teach science in her practicum. She originally enjoyed science as a child, but had a bad experience with one teacher and became separated from science education. Despite her past falling out with science, she understands that regardless of interest in content knowledge it is important to be enthusiastic in order to engage the students to learn.

The following code, Y/54/T/60/Y, also represented a participant who took both the SEMSurvey and the SEMQuestionnaire. Data from the SEMSurvey indicate that this individual is a 21-25 year old female, whose teachable is History. The last time she studied science was in second year university. She showed a Pre-Mindset score of 40, a Pre-Self-Efficacy score of 41, a Post-Mindset score of 47, and a Post-Self-Efficacy score of 48. SEMQuestionnaire responses are listed in Table 4. In reference to Table 4, she had a difficult experience in teaching science because she had not taken a science methodology class. As a child, she was not interested in learning science. As a teacher,

she faced challenges teaching science because of her content knowledge, but she understands that struggling teachers raise struggling students. She thinks that students will be more capable of learning when their teacher is confident and knows the material.

### *Additional Analysis*

A further inquiry lead me to pose another question that has been studied: What demographic factors affect self-efficacy and/or mindset? To determine what other variables affect Self-Efficacy and Mindset scores, I analyze the full set of pre-SEMSurvey data ( $N=56$ ) only and compared the results between various factors including gender, teaching division, and the last time participants studied science. Only the pre-SEMSurvey data is utilized for this because hypothetically, the sample population has not yet been exposed to the full experience of the first year B.Ed program. Without full exposure, participants should not yet be influenced by factors that have been shown to increase self-efficacy/mindset, such as methodology classes, professional development opportunities, reflective practices, practice teaching, etc. I utilize the full pre-SEMSurvey participants ( $N=56$ ) because it allows a wider range of descriptive information than the paired sample ( $N=32$ ). This full pre-SEMSurvey participant data depicts a normal distribution for Self-Efficacy score ( $M=54.95$ ,  $SD=10.321$ ,  $SE=1.379$ ,  $Skewness=0.233$ ,  $Kurtosis=-0.218$ , Shapiro-Wilk Statistic=0.985,  $p=0.710$ ). However, the Pre-Mindset distribution shows a non-normal distribution ( $M=38.13$ ,  $SD=5.103$ ,  $SE=0.682$ ,  $Skewness=-0.773$ ,  $Kurtosis=0.523$ , Shapiro-Wilk Statistic=0.930,  $p=0.003$ ). Again, transformations were unable to provide a  $p$ -value of greater than 0.05. The next paragraph will discuss how I addressed this issue.

I sought out to conduct a multi-way ANOVA to determine whether the aforementioned demographic factors affect mindset or self-efficacy, but was faced with the issue of pre-Mindset data in violation of ANOVA's assumption of normality. All other ANOVA assumptions are met: the sample size is larger than 30 ( $N=56$ ), the dependent variable(s) are continuous/interval, the independent variables (gender, teaching division, and last time studying science) have two or more categories, the observations are independent of each other, and the variances are close to equal. I needed to conduct a multi-way ANOVA because there may be more than one factor influencing mindset and/or self-efficacy (Results displayed in Table 8). In conducting a multi-way ANOVA samples also need to follow a Gaussian distribution, and since pre-Mindset data violates this I need to find a nonparametric test that will perform the same functions as an ANOVA. However, there is no recorded nonparametric test for conducting a multi-way ANOVA. If I were to conduct a one-way ANOVA, I would use the Kruskal-Wallis for the non-normal pre-Mindset data, but no nonparametric test exists for a multi-way ANOVA.

Table 8  
*Alternate Variables and their effects on Self-Efficacy and Mindset in Teaching Science*

Variable		Self-Efficacy			Mindset	
		<i>N</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>
Gender	Female	44	0.118	0.733	0.22	0.884
	Male	12				
Teaching division	P/J	23	0.038	0.846	0.472	0.496
	J/I	33				
Last time studying science	High school	32	0.172	0.680	0.072	0.790
	University	24				

*Note.* ANOVA results.  $N=56$ . The sample size represents all of the participants in the Pre-Survey. Mindset results were subjected to the Bootstrap function.

Due to my relatively small sample size, I wondered if a larger sample size would increase the normality of the distribution, thereby allowing me to use the multi-way ANOVA. I performed the Bootstrap function in SPSS and hypothetically increased the sample size to 1000, with a seed value was 2000000. The Bootstrap function normalized the distribution, allowing me to conduct the multi-way ANOVA for the Pre-Mindset data.

## CHAPTER 5: DISCUSSION

In this research, literature relevant to the construct of self-efficacy and mindset provided the theoretical framework for analysis. The literature review in *Chapter 2* supports the theoretical frameworks of self-efficacy and implicit theories of intelligence. *Chapter 3* explains the methodologies used to analyze the quantitative mindset and self-efficacy data in an explanatory approach. These data are further examined in *Chapter 4*, and qualitative questionnaire data is analyzed via a cross-case study analysis that matches the qualitative data to the quantitative data. Using these approaches, the purpose of this research is to understand if, and if so, how, elementary pre-service teacher candidates' mindsets affect their self-efficacy in science teaching in the first year of the new B.Ed program at the University of Windsor.

In this chapter, I interpret the quantitative and qualitative results that were obtained through the previous analyses conducted. Following the outline of my research questions, in summary, I found that (1) There is a relationship between mindset and self-efficacy in teaching science; (2) The first year of the B.Ed program does not significantly affect mindset and self-efficacy in teaching science; and that (3) Pre-service teacher candidates think that teachers must have positive mindsets about science, and be confident in their abilities to teach science in order for students to learn. As an additional inquiry, I also found that demographic factors may not influence self-efficacy or mindset.

### *Interpreting Quantitative Results*

*RQ1*) In reference to Table 5, the majority of participants exhibit both a GM and a High Self-Efficacy in both the pre- and post-SEMSurvey. Of the thirty-two cases analyzed, only four showed a FM score paired with a High Self-Efficacy score, and five

cases showed a Low Self-Efficacy Score paired with a GM score (Refer to bolded scores in Table 5). These 9 cases were not significant enough to pose a strong deviation from the mean scores. This observational analysis of the data suggests that there is a relationship between mindset and self-efficacy in the paired sample of elementary teacher candidates, but this needs to be verified statistically.

To verify this observation statistically, Spearman's Rho Correlation analysis of the paired pre- and post-SEMSurvey data show that there is a moderate association between pre-Mindset and pre-Self-Efficacy ( $r_s=0.498$ ) data. There is weaker association between post-Mindset and post-Self-Efficacy ( $r_s=0.198$ ). Results from Spearman's Rho Correlation analysis provides evidence to refute the null hypothesis of no relationship between mindset and self-efficacy and to support the alternative hypotheses that elementary teacher candidates with a high self-efficacy may show a growth mindset and vice versa.

In the Pearson Correlation analysis, if both Mindset and Self-Efficacy data are assumed to be normal, Cohen's standard is used to evaluate the correlation coefficients to determine the strength of the relationship. According to this method, there is a moderate association between pre-Mindset and pre-Self-Efficacy ( $r_p=0.479$ ) data. This indicates that there is a moderate relationship between mindset and self-efficacy in teaching science before being subjected to teaching elementary science. There is weaker association between post-Mindset and post-Self-Efficacy ( $r_p=0.093$ ).

Overall, statistically based on both Spearman's Rho and the Pearson Correlations, there is a positive relationship between mindset and self-efficacy in science teaching in elementary pre-service teacher candidates enrolled in the B.Ed program at the University



of Windsor. This result is in partial alignment with Bandura and Wood's model (1989). Participants who are assessed with a High Self-Efficacy in science score tend to have a GM score, and this relationship is hypothesized in Bandura and Wood's model. However, the same cannot be said about participants with a Low Self-Efficacy score/FM score in the current study. Bandura and Wood's (1989) model suggests that those with low self-efficacy in science possess a fixed/entity mindset, but in the current study there is not enough data to support this side of the model. In this study, the majority of the data were representing pre-service teacher candidates with a GM and high self-efficacy. The normal distribution was based on the majority of GM, high self-efficacy teachers. If the data showed a more even distribution between GM/FM and high/low self-efficacy, analyses could have tested the proposed relationship between FM and low self-efficacy as well.

In a sense, it seems reassuring to know that, based on scoring measures, the majority of the future elementary teachers from Windsor have a high self-efficacy and growth mindset. It is reassuring because high self-efficacy in teachers has been reported to increase student performance (Bandura, 1977; Koballa et al., 2007), and mindset studies have shown that growth mindsets also increase performance (Boaler, 2013; Blackwell and Dweck, 2007).

The correlation in this study provides supportive reasoning to Bandura and Wood's proposed model (1989) that Dweck's theory of mindset and Bandura's theory of self-efficacy are similar concepts. This seems logical because both theories are based on the SCT. If this is true, than both mindset and self-efficacy should increase together, if at all.

*RQ2*) It was hypothesized that after having two practicum experiences (November 23-December 4, 2015; February 22-March 31), mindset and self-efficacy should increase. According to the scores of the paired data in Table 4, mindset and self-efficacy increased slightly, but is it significant enough to refute the null hypothesis?

Assuming that the data sets are all normally distributed, the Repeated Measures Analysis tests for a significant difference in the data sets, where  $p < 0.05$  there is a significant difference between the data sets and the null hypothesis is rejected. This analysis resulted in statistically insignificant values of  $p = 0.934$  for the difference in mean scores of pre- and post-Mindset and  $p = 0.724$  for the difference in mean scores of pre- and post-Self-Efficacy. Statistics provide evidence to support the null hypothesis that there is no difference between the mean scores of the pre- and post-SEMSurvey in elementary pre-service teach candidates.

When considering that the post-Mindset data is non-normal, the Wilcoxon Signed-Rank Test result showed a  $p$ -value of 0.627, which is also indicative of a statistically insignificant difference in the pre- and post-Mindset mean scores. This statistic provides further evidence to not reject the null hypothesis and that there is no significant difference between mindset and self-efficacy throughout the first year of the new two-year B.Ed program at the University of Windsor.

At first, this result did not seem logical because the first year of the new two-year B.Ed program was supposed to act as an intervention and improve self-efficacy in science. This hypothesis was based on literature that has utilized science methodology classes, professional development workshops in science, reflective practices, lesson study, and peer coaching (Hamzeh, 2014; Kelley, 2004; Posnanski, 2002; Sanguenza,

2010; Wingfield, et al., 2000) as interventions to improve self-efficacy in science. I expected to see at least a minimally significant increase in self-efficacy results based on the literature. The intervention in this study includes science methodology classes, professional development workshops, reflective practices, lesson study, and peer coaching, as a whole. Initially, I had made the assumption that science methodology classes would be a factor throughout the study, which in past research (Sanguenza, 2010) has been shown to be increase self-efficacy. However, the P/J division participants were not enrolled in a science methodology course due to the layout of the new B.Ed program. Since the P/J participants were not enrolled in the science methodology course, this study's insignificant difference between pre- and post-SEMSurvey is justified if there is little weight on the effects that professional development, reflective practices, lesson study, and peer coaching have on self-efficacy and mindset.

Of the professional development, reflective practices, lesson study, and peer coaching experiences, these factors may also have contributed to the non-significant difference between pre- and post- mindset and self-efficacy. These factors may not have been specific to science, which would have directly affected the self-efficacy portion of the SEMSurvey. This also leads to a problem with the instrumentation.

The self-efficacy portion of the SEMSurvey is based specifically on science-teaching in pre-service teacher candidates (Enochs and Riggs, 1990), whereas the mindset portion of the SEMSurvey is not specific to science, nor teachers (Dweck, 1999). The mindset portion is general to intelligence of any kind. Although mindset and self-efficacy measures were combined into one survey and it was implied that the survey is specific to science teaching, the mindset test is not specific to science. This also raises the question

of whether mindset is subject specific. To make the mindset portion of this survey more specific, I could have substituted the words “intelligence in science” for simply “intelligence.” However, this would potentially decrease the validity of the ITIS instrument.

This study requires further assessment for when the participants experiences the science methodology classes in the second year of the two-year B.Ed program. My hypothesis for when they are enrolled in the methodology class is that there will be a stronger difference in self-efficacy and mindset than there is evaluated now. Studying this in the future may also provide insight into the layout of the B.Ed program and possible restructuring of it to promote higher pre-service teacher performance achievement in their practicum teaching experiences. Ultimately, this would produce a larger population of competent novice teachers and, subsequently a larger population of competent students.

### *Interpreting Qualitative Results*

*RQ3*) The qualitative data provided by the SEMQuestionnaire is used to support the quantitative findings. Although participants of the SEMQuestionnaire cover a thorough range of all of the elementary grade levels (JK-8), the small sample size of four respondents does not provide much support for the quantitative SEMSurvey results.

Quantitative SEMSurvey results suggested that the majority of teachers possess a GM and high self-efficacy, whereas qualitative results suggest otherwise. Respondents of the questionnaire display a written, reflective understanding that a growth or “positive” (as they described it) mindset and a high self-efficacy or “confidence” (as they describe it) are needed to empower students to learn. However, their earlier responses explain their discomfort or “unpreparedness” in teaching science at any level, which is contradictory to

the formerly described thoughts and the quantitative SEMSurvey results. It seems that they believe that self-efficacy and mindset influence students, but they do not possess the qualities. To understand this discrepancy further, I paired survey and questionnaire data. Of the four questionnaire respondents, the two who had matching self-generated codes had GM scores (as classified by the scoring system in *Chapter 3: Instrumentation*) and high self-efficacy scores (*Chapter 3: Instrumentation*), but they explained that they had challenges teaching science. Respondents indicated that this was due to the lack of science methodology classes. This point supports the previously noted explanation in *RQ2* for the lack of expected change in mindset and self-efficacy over the first year of the B.Ed program.

A possible reason for inconsistency between qualitative and quantitative results is that the qualitative SEMQuestionnaire gears questions of mindset specifically towards science teaching, whereas the SEMSurvey leaves mindset objective. Again this could have been avoided by substituting the words “intelligence in science” for simply “intelligence.” However, this would decrease the validity of the ITIS instrument.

A limitation to this section of the study is that the sample is very small. This cross-case analysis cannot give accurate explanations of results for the entire sample of pre-service teacher candidates. The opinions discussed in this section would be stronger if the sample size of the SEMQuestionnaire was larger; however, these qualitative data are still useful because they provide insight into the present study and future research.

### ***Interpreting the Additional Question***

The ANOVA in Table 8, suggests that there are no significant differences in mindset nor self-efficacy based on the demographics used in the SEMSurvey. The result

that disciplinary background experience does not significantly ( $p=0.790$ ,  $N=56$ ) affect teacher performance in science is in alignment with Mulholland's (2004) findings. Hubacz (2013) finding that female teachers who tended to have higher self-efficacy was not supported through the statistical results from the current study's ANOVA ( $p=0.884$ ,  $N=56$ ). Similarly, the teachable does not have a significant role in teacher self-efficacy or mindset ( $p=0.496$ ,  $N=56$ ); this result does not support the literature (Alvarez, 2008; Kirik, 2013; Lekhu, 2013).

## CHAPTER 6: CONCLUSION

This chapter includes an overall summary of the study, findings and implications of findings, limitations of the study, and recommendations for future research.

### *Study Summary*

The purpose of this study was to examine elementary pre-service teacher candidates' mindsets and self-efficacy in teaching science in the first year of the two year B.Ed program at the University of Windsor.

In the fall of 2015, 56 pre-service elementary teacher candidates, enrolled in the new two-year B.Ed program at the University of Windsor, voluntarily participated in a study in which they completed a pre- and a post-survey (only 44 completed this) that assessed their self-efficacy in science and their mindset. The pre-survey was electronically sent through the Faculty of Education's emailing system at the beginning of the second practicum, and the post-survey was sent after the final practicum of the year was complete.

The survey compiled items from the Personal Science Teaching Efficacy (PSTE) section of the STEBI-B (Enochs and Riggs, 1990), which indicates pre-service teachers' beliefs of their ability to teach science, and the Implicit Theories of Intelligence Scale (ITIS) (Dweck, 1999), which indicates the pre-service teachers' intellectual ability is either fixed or incremental. This context is important because it gives a perspective of pre-service teachers' abilities in teaching science. To understand where teacher performance in science stems from, internal characteristics of self-efficacy and mindset are studied.

### *Findings and Implications*

SEMSurvey results suggest that the majority of teachers have a GM and a high level of self-efficacy, this implies that teachers should theoretically be high performers in teaching science. However, student science scores suggest otherwise (OECD, 2014; TIMSS, 2011), and SEMQualitative data provides insight that contradicts the major SEMSurvey results. This indicates that the SEMSurvey may be leading to false positive results, where it is inaccurately categorizing teacher candidate levels of self-efficacy and mindset. This result provides evidence to reconsider and reevaluate the validity of the self-efficacy and mindset instrumentation.

The study found that there is a positive correlation between a growth mindset and high self-efficacy, which provides evidence to partially, but not conclusively, support Bandura and Wood's (1989) proposed model. It is inconclusive because the result does not provide insight into the low self-efficacy and fixed mindset correlation of Bandura and Wood's (1989) model. This result implies that pre-service teachers with a high self-efficacy in science may be influenced by a growth mindset and vice versa. The results for participants with low self-efficacy are not as strong in the determination of a correlation and cannot infer any relationship with regards to teacher candidates in these categories. Elementary teachers can use the studied relationship between growth mindset and high self-efficacy as a motivational factor to develop their internal characteristics surrounding science teaching. With respect to their students, teachers can also use this relationship as a basis to motivate their students in science.

Another finding of no significant change in mindset or self-efficacy over the first year of the new B.Ed program suggests that the first year does not affect mindset nor self-



efficacy in teaching science. This implies that the educational components within the first year of the B.Ed program (science methods classes (if any), professional development workshops, and reflective practices) do not provide a strong enough basis for the development of effective teachers. This indicates that the first year of the B.Ed program may need to be edited to be more effective in educating the pre-service teacher candidates about teaching science. Teacher educators may consider using my study as a factor to improve the program.

A qualitative suggestion that mentorship may be a strong factor that influences self-efficacy and/or mindset implies that more attention be placed on mentorship in the B.Ed program, and that more research should be conducted with regards to mentoring. This suggestion may also provide evidence to support amendment of the new B.Ed program, with respect to teacher candidates spending more time with their advisors and teaching associates. When there is more time allotted for teacher candidates to converse with their mentors, they can learn how to reflect deeper, modify lessons, and ultimately how to improve their performance.

Overall, pre-service elementary teacher candidates can use my findings to work on improving their teaching performance. Teacher educators can also use my findings to improve their performance and their B.Ed program by encouraging their students to develop higher levels of self-efficacy and mindset.

### *Limitations*

There are several limitations to this study. First, there is a lack in Canadian research in Mindset. Mindset is a newer concept than the theory of self-efficacy, and although it is used interchangeably with “implicit theories of intelligence,” Mindset’s

emergence has just recently gained interest. More specifically, mindset is being studied and improvement initiatives are being applied in the American education systems, as the creator of the concept is an American resident (Dweck, 2006).

Lack of research of Mindset in teachers is also a limitation. Mindset research has focused on student participants because researchers assumes that mindset is more malleable in the earlier years of life (Mundkur, 2005; Mahncke, et al., 2005) and that because adult brains are already formed there is a lower chance for mindset research to be applied to adult population.

My research study was constructed around the assumption that I would obtain up to 89 pre-service elementary teacher candidates. However, due to lack of voluntary participation, the study only obtained results from a maximum of 56 participants. For my comparative explanatory analysis, this sample size was broken down further as there were only 32 participants that participated in data collection methods. The original instruments required a minimum of 29 participants to measure self-efficacy (Enochs and Riggs, 1990) and 32 participants to measure mindset (Chiu et al., 1999). This sample size was just appropriate for comparison to its pervious studies. However, the sample may be too small to allow for generalizability. The cross-methods analysis of qualitative and quantitative results also incurred the issue of a small sample. Of the thirty-two participants that had matching pre- and post-SEMSurvey data, only two of four respondents for the SEMQuestionnaire were matched to their SEMSurvey data. These ideas and opinions cannot be applied to the whole population of pre-service elementary teacher candidates, and, thus, the generalizability is a major limitation of this study.

Another limitation to this study lies in the fact that the pre-SEMSurvey was given in the second practicum as opposed to the originally planned first practicum. The distribution of the surveys in the second practicum may not have provided a very truthful description of participant mindset and self-efficacy going into the B.Ed program because they had already experienced one practicum. In this first practicum period, participants could have been exposed to factors that, based on the literature, could have influenced their mindset and self-efficacy (Kelley, 2004; Hamzeh, 2014; Posnanski, 2002; Sanguenza, 2010; Wingfield, et al., 2000). Thus, the delay of distribution of the survey does not provide a very accurate baseline measure of mindset and self-efficacy for comparison to the post-survey, but it is a baseline nonetheless.

### ***Recommendations for Further Studies***

Despite the limitations, the findings of this research suggest a positive relationship between high self-efficacy and growth mindset. This finding partially supports Bandura and Wood's (1998) proposed model, but because there is a lack of data that reports low self-efficacy and a fixed mindset correlation, more research should be conducted. For future studies, larger sample sizes should be used for more powerful analyses of both the SEMSurvey and the SEMQuestionnaire.

In *Chapter 3: Instrumentation*, I justified using the General ITIS version of Dweck (1999) because I understood that it was a more reflective measure of mindset than the Self-Theory ITIS. I believed that this was the best measure for the study because it matched the reflective nature that the Faculty of Education promotes in their pre-service teacher candidates. It would be interesting to see if the Self-Theory ITIS items affect the correlation of mindset and self-efficacy differently than that of the General ITIS.

It would be interesting to repeat this study in the second year of University of Windsor's B.Ed program in order to determine if the second year of the program has an effect on self-efficacy or mindset. This would be beneficial to the University because it would pose evidence on whether the program needs to be revised in regards to the elementary pre-service teacher science-teaching education.

## REFERENCES

- Alvarez, R. (2008). The relationship of teacher quality and student achievement in elementary schools from New York City. (Doctoral dissertation). Retrieved on March 17, 2016, from: <http://eric.ed.gov/?id=ED538000>
- Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology, 80*(3), 260-267.
- Anderman, E., & Mueller, C. (2010). Middle school transitions and adolescent development. In Meece & Eccles, *Handbook of research on schools, schooling, and human development* (pp. 198-215). New York, NY: Routledge.
- Ashton, P., Olejnik, S., Crocker, L., & McAuliffe, M. (1982). *Measurement problems in the study of teachers' sense of efficacy*. Paper presented at the annual meeting of the American Educational Research Association, New York, NY.
- Ashton, P., Buhr, A., & Crocker, L. (1984). Teachers' sense of efficacy: A self- or norm-references construct? *Florida Journal of Educational Research, 26*(1), 29-41.
- Ashton, P., & Webb, R. (1982). *Teachers' sense of efficacy: Toward an ecological model*. Paper presented at the annual general meet of the American Educational Research Association, New York.
- Atkinson, J. (1957). Motivational determinants of risk-taking behavior. *Psychological Review, 64*, 359-372.
- Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191-215. DOI:10.1037/0033-295X.2.191

- Bandura, A. (1986). *Social foundation of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice - Hall.
- Bandura, A. (1995). *Exercise of personal and collective efficacy in changing societies*. New York, NY: Cambridge University Press.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W.H. Freeman and Company.
- Bartley, J. (2013). The impact of first, second and third grade teachers on third grade student ISTEP+ scores. (Unpublished dissertation). Indiana State University, Terre Haute, IN.
- Bergman, D., & Mophew, J. (2015). Effects of a science content course on elementary pre-service teachers' self-efficacy of teaching science. *Journal of College Science Teaching, 44(3)*, 73-81.
- Blackwell, L., Trzesniewski, K., & Dweck, C. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78*, 246–263.
- Blase, J., & Greenfield, W. (1980). An interactive /cyclical theory of teacher performance. *Administrators Notebook, 29(5)*, 1-4.
- Bleicher, R., & Lindgren, J. (2005). Learning the learning cycle: The differential effect on elementary pre-service teachers. *School Science and Mathematics, 105(2)*, 61-72.
- Bleicher, R.E., & Lindgren, J. (2005). Success in science learning and pre-service science teaching self-efficacy. *Journal of Science Teacher Education, 16(3)*, 205-225.

- Bleicher, R. (2010). Revisiting the STEBI-B: Measuring self-efficacy in pre-service elementary teachers. *School Science and Mathematics, 104*(8), 383-391.
- Boaler, J. (2013). Ability and mathematics: The mindset revolution that is reshaping education. *Promoting Comprehensive Education, 55*(1), 143-152.
- Boone, W., Staver, J., & Yale, M. (2015). *Rasch Analysis in the Human Sciences*. (pp. 24-30). New York, NY: Springer.
- Borchers, C., Shroyer, M., & Enochs, L. (1992). A staff development model to encourage the use of microcomputers in science teaching in rural schools. *School Science and Mathematics, 92*(7), 384-391.
- Brewer, J., & Hunter, A. (2006). *Collecting data with Multiple Methods: Foundations of Multimethod Research* (pp. 64-71). London, UK: Sage Publications, Inc.
- Brooks, R. & Goldstein, S. (2008). The mindset of teachers capable of fostering resilience in students. *Canadian Journal of School Psychology, 23*(1), 114-125.
- Brooks, R., & Goldstein, S. (2007). *Understanding and Managing Children's Classroom Behavior*. John Wiley & Sons. New York, NY.
- Bruce, C., Esmonde, I., Ross, J., Dookie, L., & Beatty, R. (November, 2010). The effects of sustained classroom-embedded teacher professional learning on teacher efficacy and related students achievement. *Teaching and Teacher Education, 26*(8), 1598-1608.
- Bruno, R., Merzenich, M., & Nudo, R. (2012). The fantastic plastic brain. *Advances in Mind-body Medicine, 26*(2), 30-35.

- Bursal, M., & Paznakos, L. (2006). Mathematics anxiety and pre-service elementary teachers' confidence to teach mathematics and science. *School of Science and Mathematics, 106*(4), 173-180.
- Bursal, M. (2008). Changes in Turkish pre-service elementary teachers' personal science teaching efficacy beliefs and science anxieties during a science method course. *Journal of Turkish Science Education, 5*, 99-112.
- Buss, R. (2010). Efficacy for teaching elementary science and mathematics compared to other content. *School Science and Mathematics, 110*(6), 290-297.
- Cakiroglu, E., & Boone, W. (2005). Pre-service teacher self-efficacy beliefs regarding science teaching: A comparison of pre-service teachers in Turkey and the USA. *Science Educator, 14*(1), 31-40.
- Chomeya, R. (2010). Quality of psychology test between Likert scale 5 and 6 points. *Journal of Social Sciences, 6*(3), 399-403.
- Chong, W., & Kong, C. (2012). Teacher collaborative learning and teacher self-efficacy: The case of lesson study. *The Journal of Experimental Education, 80*(3), 263-283.
- Christensen, C., Johnson, C., & Horn, M. (2008). *Disrupting class: How disruptive innovation will change the way the world learns*. New York, NY: McGraw-Hill Professional.
- Cleary, T., Callan, G., Malatesta, J., & Adams, T. (2015). Examining the level of convergence among self-regulated learning microanalytic processes, achievement, and a self-report questionnaire. *Journal of Psychoeducational Assessment, 33*(5), 439-450.



- Clotfelter, C., Ladd, H., & Vigdor, J. (2006). Teacher-student matching and the assessment of teacher effectiveness. *Journal of Human Resources, 41*, 778-820.
- Colton, K. (2003). Principals and student achievement. Alexandria, VA: Association for Supervisor and Curriculum Development.
- Cotton, K. (2003). *Principals and Student Achievement*. Melbourne: Hawker Brownlow Education.
- Cruickshank, D. (1990). *Research that informs teachers and teacher educators*. Bloomington, IN: Phi Delta Kappa Educational Foundation.
- Darling-Hammond, L. (2000). Teacher quality and students achievement. *Education Policy Analysis Archives, 8(1)*, 1-44. Retrieved on March 25, from: <http://epaa.asu.edu/ojs/article/view/392>
- DeCastella, K., & Byrne, D. (2015). My intelligence may be more malleable than yours: The revised implicit theories of intelligence (Self-theory) scale is a better predictor of achievement, motivation and student disengagement. *European Journal of Psychology of Education, 30*, 245-267.
- Deci, E., Koestner, R., & Ryan, R. (2001). Extrinsic rewards and intrinsic motivation in education: Reconsidered once again. *Review of Educational Research, 71(1)*, 1-27.
- Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*. Boston, MA: D.C. Heath and Company.
- Dinsmore, D., Alexander, P., & Loughlin, S. (2008). Focusing on the conceptual lens on metacognition, self-regulation, and self-regulated learning. *Educational Psychology Review, 20*, 391-409.

- Doidge, N. (2007). *The brain that changes itself: Stories of personal triumph from the frontiers of brain science*. New York, NY: Viking.
- Duckworth, A., Peterson, C., Matthews, M., & Kelly, D. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology, 92*, 1087–1101.
- Duckworth, A., & Quinn, P. D. (2009). Development and Validation of the Short Grit Scale (Grit-S). *Journal of Personality Assessment, 91*(2), 166-174.
- Dupeyrat, C., Marine, C. (2004) Implicit theories of intelligence, goal orientation, cognitive engagement, and achievement: A test of Dweck's model with returning to school adults. *Contemporary Educational Psychology, 30* (1), 43-59.
- Dweck, C. (1999). *Self-theories: Their role in motivation, personality and development*. Taylor & Francis: Philadelphia, PA.
- Dweck, C. (2006). *Mindset: The new psychology of success*. Ballantine Books. New York, NY.
- Dweck, C. (2007). The Growth Mindset. Retrieved March 20, 2015, from <http://www.mindsetworks.com/webnav/whatismindset.aspx>. 12.
- Dweck, C. (2008). Brainology transforming students' motivation to learn. *Independent School, 67*(2), 110-119.
- Dweck, C., Chiu, C., & Hong, Y. (1995). Implicit theories: Elaboration and extension of the model. *Psychological Inquiry, 6*(4), 322-333.
- Dweck, C. (1986). Motivational processes affecting learning. *American Psychologist, 41*(10), 1040-1048.

- Dweck, C., & Leggett, E. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, 95(2), 256-273.
- Education Act. (2007). Ontario Regulation 99/02: Teacher Performance Appraisal. (p. 8).  
Ottawa, ON: Queens Printer for ON.
- El-Deghaidy, H. (2006). An investigation of pre-service teacher's self-efficacy and self-image as a science teacher in Egypt. *Asia-Pacific Forum on Science Learning and Teaching*, 7(2), 22.
- Enochs, L. & Riggs, I. (1990). Further development of an elementary science teaching efficacy belief instrument: A pre-service elementary scale. *School Science and Mathematics*, 90, 694-706.
- Erdley, C., & Dweck, S. (1993). Children's implicit theories as predictors of their social judgments. *Child Development*, 64, 863-878.
- Fulp, S. (2002). Status of Elementary School Science Teaching. Retrieved on February 20, 2016, from: [http://2000survey.horizon-research.com/reports/elem\\_science/elem\\_science.pdf](http://2000survey.horizon-research.com/reports/elem_science/elem_science.pdf)
- Fulk, B., Brigham, F., & Lohman, D. (1998). Motivation and self-regulation. *Remedial and Special Education*, 19(5), 300-309.
- Fulton, J., & Sabatino L. (2008). Using the scientific method to motivate biology students to study precalculus. *Primus*, 18(1), 5-21.
- Garcia, M., & McCoach, D. (2009). Educators' implicit theories of intelligence and beliefs about the identification of gifted students. *Universitas Psychologica*, 8(2), 295-310.

- Gaskill, P., & Woolfolk, A. (2002). Self-efficacy and self-regulated learning: the dynamic duo in school performance. In J. Aronsor and D. Cordora (Eds.), *Improving education: Classic and contemporary lessons from psychology* (pp. 183-206). New York, NY: Academic Press.
- Gerde, H., Schachter, R., & Wasik, B. (2013). Using the scientific method to guide learning: An integrated approach to early childhood curriculum. *Early Childhood Education Journal*, *41*(5), 315-323.
- Gero, G. (2013). *What drives teachers to improve? The role of teacher mindset in professional learning*. (Doctoral dissertation). The Claremont Graduate University, #3605669.
- Gibson, S., & Dembo, M. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology*, *76*(4), 569-582.
- Giddings, L. (2005). Factors influencing teaching style in block-scheduled science classrooms. Doctoral dissertation. Hofstra University.
- Goldstein, S., Brooks, R., & DeVries, M. (2013). Translating resilience theory for applications with children and adolescents by parents, teachers and mental health professionals. In *Resilience in Children Adolescents, and Adults*. S. Prince-Embury and D. Saklofske (Eds.). The Springer Series on Human Exceptionality. New York, NY.
- Goodrum, D., Hackling, M., & Rennie, L. (2001). *The status and quality of teaching and learning of science in Australian schools*. A research report prepared for Department of Education, Training and Youth Affairs. Canberra: Department of Education, Training and Youth Affairs.

- Gunning, A., & Mensah, F. (2011). Pre-service elementary teachers' development of self-efficacy and confidence to teach science: A case study. *Journal of Science Teacher Education, 22*(2), 171-185.
- Hamzeh, F. (2014). *Lesson study-building communities of learning among pre-service science teachers*. Master's dissertation. University of Windsor, #1562240.
- Harris, D., & Sass, T. (2011). Teacher training, teacher quality and student achievement. *Journal of Public Economics, 95*(7-8), 798-812.
- Henderson V., Dweck, C., & Chiu, C. (1992). *A measure of implicit theories of intelligence*. Unpublished manuscript, Columbia University, New York, NY.
- Higgins, E., & Kruglanski, A. (2000). Motivational science, social and personality perspectives. *Psychology Press, 203*.
- Henson, R. (2001). *Teacher self-efficacy: Substantive implications and measurement dilemmas*. Manuscript from keynote address given at the annual meeting of the Educational Research Exchange.
- Hochanadel, A., & Finamore, D. (2015). Fixed and growth mindset in education and how grit helps students persist in the face of adversity. *Journal of International Education Research, 11*(1), 47-50.
- Holloway, S., & Salinitri, G. (November, 2010). Investigating teacher candidates' mentoring of students at risk of academic failure: A Canadian experiential field model. *Mentoring & Tutoring: Partnership in Learning, 18*(4), 383-403.
- Hong, Y., Chiu, C., Dweck, C., Lin, D., & Wan, W. (1999). Implicit theories, attributions, and coping: A meaning system approach. *Journal of Personality and Social Psychology, 77*(3), 588-599.

- Howes, E. (2002). Learning to teach science for all in the elementary grades: What do preservice teachers bring? *Journal of Research in Science Teaching*, 39(9), 845-869.
- Howitt, C. (2007). Pre-service elementary teachers' perceptions of factors in a holistic methods course influencing their confidence in teaching science. *Research in Science Education*, 37, 44-58.
- Hoy, W., & Miskel, C. (2013). *Educational Administration: Theory, research, and practice. Chapter 4. Ninth Edition*. Mc-Graw Hill Companies: New York, NY.
- Hubacz, M. (2013). *How a teacher's sense of self-efficacy and implicit theory of intelligence relate to student achievement in mathematics*. Master's dissertation. University of New Hampshire.
- Ingvarson, L., Meiers, M, & Beavis, A. (2005). Factors affecting the impact of PD programs on teachers' knowledge, practice, student outcomes and efficacy. *Education Policy Analysis Archives*, 13(10), 28.
- Irez, S. (2006). Are we prepared?: An assessment of pre-service science teachers educators' beliefs about nature of science. *Science Education*, 90, 1113-1143. DOI: 10.1002/sce.20156
- Jennings, J., & DiPrete, T. (2009). Teacher effects on social and behavioral skills in early elementary school. *Sociology of Education*, 83, 135-159.
- Jones, B., Bryant, L., Snyder, J., & Malone, D. (2012). Pre-service and inservice teachers' implicit theories of intelligence. *Teacher Education Quarterly*, 39(2), 87.

- Kahle, J.B., & Boone, W. (2000). Strategies to improve student science learning: Implications for science teacher education. *Journal of Science Teacher Education, 11*, 93-107. DOI: 10.1023/A:1009432007059
- Kazempour, M. (2014). I can't teach science! A case study of an elementary pre-service teacher's intersection of science experiences, beliefs, attitude, and self-efficacy. *International Journal of Environmental and Science Education, 9(1)*, 77-96.
- Kelley, M. (2004). Why induction matters. *Journal of Teacher Education, 55*, 438-448.
- Kernis, M. (1995). *Efficacy, agency and self-esteem*. New York, NY: Plenum Press.
- Kirik, D. (2013). Science teaching efficacy of pre-service elementary teachers: Examination of the multiple factors reported as influential. *Research in Science Education, 43*, 2497-2515.
- Koballa, T., & Grynns, S. (2007). Attitudinal and motivational constructs. In *Handbook of research on science education*. S.Abell and N. Lederman (Eds.) Englewood Cliffs, NJ: Erlbaum Publishers.
- Komarraju, M., & Nadler, D. (2013). Self-efficacy and academic achievement: Why do implicit beliefs, goals, and effort regulation matter? *Learning and Individual Differences, 25*, 67-72.
- Lekhu, M. (2013). Relationship between self-efficacy beliefs of science teachers and their confidence in content knowledge. *Journal of Psychology in Africa, 23(1)*, 109-112.
- Lieberman, A., & Miller, A. (1992). Teacher development in professional practice schools. In *Professional Development and Restructuring*. (pp. 2-18). In A. Lieberman (Ed.). New York, NY: Teachers College Press.

- Mahncke, H., Bronstone, A., & Merzenich, M. (2006). Brain plasticity and functional losses in the aged: Scientific bases for a novel intervention. *Progress in Brain Research, 157*, 81-109.
- Maslow, A. (1943). A theory of human motivation. *Psychological Review, 50(4)*, 370-396.
- Matheson, D. (2015). *An Introduction to the Study of Education, 4<sup>th</sup> Edition*. Routledge, 2014.
- McClelland, J., & Siegler, R. (2001). *Mechanisms of cognitive development: Behavioral and neural perspectives*. (p 67-90) Lawrence Erlbaum: Mahwah, NJ.
- McKinnon, M., & Lamberts, R. (2013). Influencing science teaching self-efficacy beliefs or primary school teachers: A longitudinal case study. *International Journal of Science Education, Part B*, 1-23.
- McWilliam, E. (2012). *Self-efficacy, implicit theory of intelligence, goal orientation and the 9<sup>th</sup> grade experience*. (Doctoral dissertation). Northeastern University, Boston, MA.
- Mendenhall, W., Beaver, R., Beaver, B., & Ahmed, S. (2009). *Introduction to Probability and Statistics*. Toronto, ON: Nelson Education
- Ministry of Education. (2013). *School Effectiveness Framework: A support for school improvement and student success*. Retrieved on April 20, 2016, from: <http://www.edu.gov.on.ca/eng/literacynumeracy/SEF2013.pdf>
- Mohamadi, F., & Asadzadeh, H. (2012). Testing the mediating role of teachers' self-efficacy beliefs in the relationship between sources of efficacy information and student achievement. *Asia Pacific Education Review, 13(3)*, 427-433



- Mulholland, J. (February 2001). Teacher induction and elementary science teaching: enhancing self-efficacy. *Teaching and Teacher Education*, 17(2), 243-261.
- Mundkur, N. (October 2005). Neuroplasticity in children. *The Indian Journal of Pediatrics*, 72(10), 855-857.
- Nenneman, P. (1971). *Factors influencing teaching methods of first, second, and third-year Nebraska University graduates in the teaching of elementary school social science*. (Doctoral dissertation). University of Nebraska, #A230460.
- Nye, B., Konstantopoulos, S., & Hedges, L. (2004). How large are teacher effects? *Educational Evaluation and Policy Analysis*, 26(3), 237-257.
- OECD, PISA. (2014). PISA 2012 Results: What students know and can do: Student performance in mathematics, reading and science (Volume 1). Retrieved on September 28, 2015, from: <http://www.oecd.org/pisa/keyfindings/pisa-2012-results-volume-i.htm>
- OCT. (2016). Standards of Practice for the Teaching Profession. Retrieved on November 10, 2015, from: [www.oct.ca/public/professional-standards/standards-of-practice](http://www.oct.ca/public/professional-standards/standards-of-practice)
- Odden, A., Borman, G, & Fermanich, M. (2004). Assessing teacher, classroom, and school effects, including fiscal effects. *Peabody Journal of Education*, 79, 4-32.
- Pajares, F. (2005). Self-efficacy during childhood and adolescence: Implications for teachers and parents. *Information Age Publishing*, 339-367.
- Palmer, D. (2006). Sources of self-efficacy in a science methods course for primary teacher education students. *Research in Science Education*, 36(4), 337-353.
- Palmer, D. (2008). Practices and innovations in Australian science teacher education programs. *Research in Science Education*, 38, 167-188.

- Pan, H. (2014). Relationships among teachers' self-efficacy and students' motivation, atmosphere, and satisfaction in physical education. *Journal of Teaching in Physical Education, 33*(1), 68-92.
- Parker, J., & Heywood, D. (1999). Exploring the relationship between subject knowledge and pedagogic content in primary teachers' learning about forces. *International Journal of Science Education, 22*(1), 89-111.
- Pintrich, P., Smith, D., Garcia, T., & McKeachie, W. (1991). *A manual for the use of the motivated strategies for learning questionnaire (MSLQ)*. Technical report no. 91-B-004, The Regents of the University of Michigan.
- Posnanski, T. (2002). Professional development programs for elementary science teachers: An analysis of teacher self-efficacy beliefs and a professional development model. *Journal of Science Teacher Education, 13*(2), 189-220.
- Ramsden, S., Richardson, F., Josse, G., Thomas, M., Ellis, C., Shakeshaft, C., Seghier, M., & Price, C. (2011). Verbal and non-verbal intelligence changes in the teenage brain. *Nature, 479*, 113-116.
- Reeve, J. (2001). *Understanding motivation and emotion, third edition*. Orlando, FL: Harcourt.
- Riles, W. (1973). Early Childhood Development. *California's Approach: The First 8 Year Count the Most*. (pp. 12-14). Compact. San Francisco, California.
- Rivkin, S., Hanushek, E., & Kain, J. (2005). Teachers, schools, and academic achievement. *Econometrica, 73*, 47-458.

- Rockoff, J. (2004). The impact of individual teachers on student achievement: Evidence from panel data. *American Economic Review, Papers and Proceedings*, 94, 247-252.
- Sanguenza, C. (2010). *Pre-service elementary science teaching self-efficacy and teaching practices: a mixed methods, dual-phase embedded case study*. Doctoral dissertation. University of Nevada, #3423785.
- Sarason, S. (1996). *Revisiting "The culture of the school and the problem of change."* New York, NY: Teachers College Press.
- Saunders, A. (2013). *Impact of a growth mindset intervention on the reading achievement of at-risk adolescent students*. Doctoral Dissertation, University of Virginia, #3573523.
- Saunders, M., Lewis, P., Thornhill, A. (2007). *Research Methods for Business Students*, 4<sup>th</sup> edition (pp. 139-142). Essex, England: Pearson Education.
- Shaugnessy, M. (2004). An interview with Anita Woolfolk: The educational psychology of teacher efficacy. *Educational Psychology Review*, 16(2), 153-176.
- Shrigley, R., & Johnston, T. (1974). The attitude of in-service elementary teachers toward science. *School Science and Mathematics*, 74(5), 437-446.
- Shulman, L. (1986). Those who understand knowledge growth in teaching. *Educational Researchers*, 15(2), 4-14.
- Sideridis, G. (2005). Goal orientation, academic achievement, and depression: Evidence in favor of a revised goal theory framework. *Journal of Educational Psychology*, 97(3) 366-375.

- Skaalvik, E., & Skaalvik, S. (2007). Dimensions of teacher self-efficacy and relations with strain factors, perceived collective teacher efficacy, and teacher burnout. *Journal of Educational Psychology, 99*, 611-625.
- Smith, M., & Scharmann, L. (1999). Defining versus describing the nature of science: A pragmatic analysis for classroom teachers and science educators. *Science Education, 83*, 493-509.
- Smolleck, L., Zembal-Saul, C., & Yoder, E. (2006). The development and validation of an instrument to measure pre-service teachers' self-efficacy in regard to the teaching of science as inquiry. *Journal of Science Teacher Education, 17*(2), 137-163.
- Steele, J., Hamilton, L., & Stecher, B. (2010). *Incorporating student performance measures into teacher evaluation systems*. Santa Monica, CA: RAND Education Corporation.
- Supovitz, J., & Turner, H. (2000). The effects of professional development on science teaching practices and classroom culture. *Journal of Research in Science Teaching, 37*, 963-980.
- Swars, S., & Dooley, C. (2010). Changes in teaching efficacy during a professional development school-based science methods course. *School Science and Mathematics, 110*(4), 193-202.
- TIMSS. (2011). Trends in International Mathematics and Science Study. Retrieved April 15, 2016, from <http://timss.bc.edu/timss2011/>
- Tschannen-Moran, & Woolfolk-Hoy, A. (2001). Teacher efficacy: Capturing an elusive concept. *Teaching and Teacher Education, 17*, 783-805.

- University of Windsor. (n.d.). Retrieved April 16, 2016, from  
<http://www1.uwindsor.ca/education/current/primaryjunior>
- Urdan T., & Turner, J. (2007). Competence motivation in the classroom. In Elliot & Dweck, *Handbook of competence and motivation* (pp 297-317). New York, NY: Guilford Press.
- Vancouver, J., Thompson, C., & Williams, A. (2001). The changing signs in the relationships between self-efficacy, personal goals, and performance. *Journal of Applied Psychology, 86*, 605-620.
- Volkman, B. (1992). *Enhancing pre-service teachers' self-efficacy through a field-based program or reflective practice*. Paper presented at the annual meetup of the Mid-South Educational Research Association, Knoxville, TN.
- Weiner, B. (1974) *Achievement motivation and attribution theory*. Morristown, NJ: General Learning Press.
- Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review, 92(4)*, 548-573.
- Wigfield, A., & Wagner, A. (2007). Competence, motivation and identity development during adolescence. In Elliot & Dweck, *Handbook of competence and motivation* (pp. 222-239). New York, NY: Guilford Press.
- Willingham, W., Pollack, J., & Lewis, C. (2002). Grades and test scores: Accounting for observed differences. *Journal of Educational Measurement, 39(1)*, 1-37.
- Wingfield, M., Freeman, L., & Ramsey, J. (2000). Science teaching self-efficacy of first-year elementary teachers trained in a site-based program. Paper presented at the

*Annual Meeting of the National Association for Research in Science Teaching,*  
New Orleans, LA.

- Windschitl, M. (2002). Inquiry projects in science teacher education: What can investigative experience reveal about teacher thinking and eventual classroom practice? *Science Teacher Education, 87*, 112-143.
- Wood, R., & Bandura, A. (1989). Impact of conceptions of ability on self-regulatory mechanisms and complex decisions making. *Journal of Personality and Social Psychology, 56* (3), 407-415.
- Woolfolk, A., & Hoy, W. (2009). *Instructional leadership: A research based guide to learning in schools, third edition*. Boston, MA: Allyn and Bacon/Longman.
- Wu, S., & Chang, Y. (2006). Teacher efficacy and elementary teacher educators. *Academic Exchange Quality, 10*(3), 75-79.
- Yaman, K. (2015). Self-efficacy and academic achievement: A case from Turkey. *Journal of Education and Practice, 6*(29), 131-141.
- Yost, D. (2006). Reflection and self-efficacy: Enhancing the retention of qualified teachers from a teacher education perspective. *Teacher Education Quarterly, 33*(4), 59-76.
- Yusuf, C. (2013). Relationship between teachers' self-efficacy beliefs and their willingness to implement curriculum reform. *International Journal of Educational Reform, 22*(3), 252-270.

## APPENDICES

Appendix A. Letter of permission to use elementary teacher candidate emails.



November 13, 2015

To Whom It May Concern,

I authorize Ms. Stephanie Palazzolo to approach the P/J and J/I students of the 2015-2017 B.Ed program via email to complete surveys. The data will be utilized in her Master's thesis in the fulfillment of her Master's degree in Education.

If you have any further questions, please do not hesitate to contact me at the information below.

Sincerely,

Geri Salinitri, PhD  
Associate Professor  
Associate Dean, Pre-service  
Faculty of Education  
University of Windsor  
(519)253 3000 ext 3961  
[sgeri@uwindsor.ca](mailto:sgeri@uwindsor.ca)

## Appendix B. Letter of Information for Consent to Participate in Research

### The relationship between mindset and self-efficacy in science teaching pre-service elementary teacher candidates, and its implications on science teaching

This study is conducted by Stephanie Palazzolo, under the supervision of Dr. Geri Salinitri, from the Faculty of Education and Academic Development at the University of Windsor. These results will contribute to the completion of the Thesis for Stephanie's M.Ed. If you have any questions or concerns about the research, please feel to contact Stephanie Palazzolo ([palazzos@uwindsor.ca](mailto:palazzos@uwindsor.ca)).

#### RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: [ethics@uwindsor.ca](mailto:ethics@uwindsor.ca)

#### PURPOSE

The purpose of this project is to examine how Primary/Junior/Intermediate pre-service teacher candidates' mindsets affect their self-efficacy in teaching science. Self-efficacy is a teacher's belief of their ability to meet their desired outcomes in teaching. Mindset one's beliefs about their own intelligence and how they can increase their achievements through motivation to influence their success. By conducting this study, we will gain insight into defining and solving problems associated with mindset and self-efficacy that elementary teacher candidates face in regards to science teaching.

#### PROCEDURES

If you volunteer to participate in this study, you will be asked to:  
SURVEY

1. Voluntarily and anonymously complete the pre-survey before practice-teaching a science class in your respective practicum. Surveys will each take approximately 15 minutes to complete. You will generate an identification code that will be used by the researchers to compare your responses for data analysis. Your identity and responses remain anonymous and confidential
2. Upon completing their final practicum as of March 31<sup>st</sup>, 2016, you will receive the link to the post-survey. You will be asked to voluntarily complete the post-survey before April 7<sup>th</sup>, 2016. Survey is identical to the pre-survey.

#### QUESTIONNAIRE

3. A final email request will be sent out to you, asking for your voluntary participation (only if you completed both pre- and post-surveys) in a short questionnaire. You will generate an identification code that will be used by the researchers to compare your responses for data analysis. Your identity and responses remain anonymous and confidential.

#### POTENTIAL RISKS AND DISCOMFORTS

If private information is released, social and economic problems may arise. Some possible perceived participant social risks include defamation, which may affect future evaluations and jeopardize career opportunities. Actual social risks are less severe because the anonymity of the survey and questionnaire does not allow researchers to identify individuals. However, if a colleague witnesses your participation, they may exploit your answers, which could affect your academic performance, which could lead to declines in future evaluations or career opportunities.



Dr. Salinitri is both a teacher and administrator. Participants may perceive her association with the study as an ability to access the data and identify participants, which could lead to being treated differently in class and having a biased evaluation in class.

Every precaution has been made to avoid these risks. We respect and protect participant confidentiality. Researchers can not publicly identify you. Your self-generated identification code and ability to privately complete the survey and questionnaire ensure your anonymity. The TRUSTe certified security approval of SurveyMonkey platform ensures participant responses remain confidential, and anonymous. Data will be deleted after September 1<sup>st</sup>, 2016. Participants may withdraw from the research at any time and may refuse to answer as many questions as they like.

#### POTENTIAL BENEFITS

Participants may directly benefit from this research by gaining an understanding about the research methods used, and gaining an understanding of their self-efficacy and mindset. A potential benefit to the scholarly community from this study is an advancement of knowledge in the field of elementary science education.

#### CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential.

Utilization of the SurveyMonkey platform provides encrypted access to the survey results. My advisor and I are the specified individuals with access to these results. A self-generated identification code (participant's month of birth, first two letters of participant's mother's name, participant's year of birth, participant's last letter of first name, participant's first letter of first name) will be developed by each participant for future data analysis. Survey results will be kept available on SurveyMonkey until September 1<sup>st</sup>, 2016 and will be deleted thereafter through my SurveyMonkey profile.

#### PARTICIPATION AND WITHDRAWAL

The participant does not have to respond to all questions in the questionnaire; they have the right to refuse responding to questions of their choosing. Interviewees may withdrawal from the questionnaire at any point by closing the browser window without clicking "Submit," these responses will be omitted from the researcher's study.

#### FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

A summary of the research findings will be available for your viewing upon request, after May 2, 2016. Please email [palazzos@uwindsor.ca](mailto:palazzos@uwindsor.ca) to request a viewing of the results.

#### SUBSEQUENT USE OF DATA

These data may be used in subsequent studies, in publications and in presentations.

#### RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: [ethics@uwindsor.ca](mailto:ethics@uwindsor.ca)

#### SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

## Appendix C. Original STEBI-B

Choose the option that best suits your agreement with each of the statements.

---

- 1- Strongly Disagree
  - 2- Disagree
  - 3- Barely Disagree
  - 4- Barely Agree
  - 5- Agree
  - 6- Strongly Agree
- 

- a) When a student does better than usual in science, it is often because the teacher exerted a little extra effort.
- b) I will continually find better ways to teach science.
- c) Even if I try very hard, I will not teach science as well as I will most subjects.
- d) When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.
- e) I know the steps necessary to teach science concepts effectively.
- f) I will not be very effective in monitoring science experiments.
- g) If students are underachieving in science, it is most likely due to ineffective science teaching.
- h) I will generally teach science ineffectively.
- i) The inadequacy of a student's science background can be overcome by good teaching.
- j) The low science achievement of students cannot generally be blamed on their teachers.
- k) When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.
- l) I understand science concepts well enough to be effective in teaching science.
- m) Increased effort in science teaching produces little change in students' science achievement.

- n) The teacher is generally responsible for the achievement of students in science.
- o) Students' achievement in science is directly related to their teacher's effectiveness in science teaching.
- p) If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.
- q) I will find it difficult to explain to students why science experiments work.
- r) I will typically be able to answer students' science questions.
- s) I wonder if I will have the necessary skills to teach science.
- t) Given a choice, I will not invite the principal to evaluate my science teaching.
- u) When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.
- v) When teaching science, I will usually welcome student questions.
- w) I do not know what to do to turn students on to science.

Enochs, L. & Riggs, I. (1990). Further development of an elementary science teaching efficacy belief instrument: A pre-service elementary scale. *School Science and Mathematics, 90*, 694-706.

## Appendix D. General ITIS

Choose the option that best suits your agreement with each of the statements.

---

- 1- Strongly Disagree
  - 2- Disagree
  - 3- Barely Disagree
  - 4- Barely Agree
  - 5- Agree
  - 6- Strongly Agree
- 

1. You have a certain amount of intelligence, and you can't really do much to change it.
2. Your intelligence is something about you that you can't change very much.
3. No matter who you are, you can significantly change your intelligence level.
4. To be honest, you can't really change how intelligent you are.
5. You can always substantially change how intelligent you are.
6. You can learn new things, but you can't really change your basic intelligence.
7. No matter how much intelligence you have, you can always change it quite a bit.
8. You can change even your basic intelligence level considerably.

Dweck, C. (2000). *Self-theories: Their role in motivation, personality and development*. Taylor & Francis: Philadelphia, PA.

## Appendix E. Self-Efficacy and Mindset Survey

### Introduction

Answering the following questions will provide insight into the level of self-efficacy and the types of mindsets pre-service teacher candidates have. This is an anonymous survey; your answers will remain confidential. You will generate an identification code that will be used by the researchers to compare your responses for data analysis. Your identity and responses remain anonymous and confidential. This research has been cleared by the University of Windsor Research Ethics Board. Please note that you may exit the survey at any time by clicking the Exit this survey at the top of the survey.

By filling out this survey, I am agreeing to allow my anonymous results to contribute to Stephanie Palazzolo's Master's thesis to fulfill requirements toward a Master's degree in Education at the University of Windsor, under the supervision of Dr. Salinitri.

NEXT

### Identification Code

**Enter the Last letter of mother's name; Age of mother; First letter of your name; Year of father's birth (yy); Last letter of father's name. (X ## X ## X)**

### Mindset

Please choose the option that best suits your agreement with each of the statements in this survey.

- 1- Strongly Disagree
- 2- Disagree
- 3- Barely Disagree
- 4- Barely Agree
- 5- Agree
- 6- Strongly Agree

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

**\* 1. You have a certain amount of intelligence, and you can't really do \* much to change it.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

**\* 2. Your intelligence is something about you that you can't change very much.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

**\* 3. No matter who you are, you can significantly change your intelligence level.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

**\* 4. To be honest, you can't really change how intelligent you are.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

**\* 5. You can always substantially change how intelligent you are.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

**\* 6. You can learn new things, but you can't really change your basic intelligence.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

**\* 7. No matter how much intelligence you have, you can always change it quite a bit.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

**\* 8. You can change even your basic intelligence level considerably.**

Dweck, C. (2006). Test Your Mindset. Mindset. Retrieved from: <http://mindsetonline.com/testyourmindset/step1.php>

### Self-efficacy

Please choose the option that best suits your agreement with each of the statements in this survey.

- 1- Strongly Disagree
- 2- Disagree
- 3- Barely Disagree
- 4- Barely Agree
- 5- Agree
- 6- Strongly Agree

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **9. I will continually find better ways to teach science.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **10. Even if I try very hard, I will not teach science as well as I will most subjects.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **11. I know the steps necessary to teach science concepts effectively.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **12. I will not be very effective in monitoring science experiments.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **13. I will generally teach science ineffectively.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **14. I understand science concepts well enough to be effective in teaching science.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **15. I will find it difficult to explain to students why science experiments work.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **16. I will typically be able to answer students' science questions.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **17. I wonder if I will have the necessary skills to teach science.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **18. Given a choice, I will not invite the principal to evaluate my science teaching.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **19. When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **20. When teaching science, I will usually welcome student questions.**

Strongly Disagree Disagree Barely Disagree Barely Agree Agree Strongly Agree

\* **21. I do not know what to do to turn students on to science.**

Enochs, L. & Riggs, I. (1990). Further development of an elementary science teaching efficacy belief instrument: A pre-service elementary scale. *School Science and Mathematics*, 90, 694-706.

### Demographics

\* **22. Gender**

- Female
- Male

Other (please specify)

**23. Select your age range.**

21-25

26-30

31-35

36-40

Other (please specify)

**24. Please select the option that best describes your ethnicity.**

European origin

North American origin

Central American origin

South American origin

Asian origin

African origin

Aboriginal origin

Other (please specify)

**\* 25. What is your teachable**

English

French

History

Arts (Drama/Music)

Biology

Chemistry

Physics

Math

Geography

Computer Science

Other (please specify)

**\* 26. When was the last time you studied science?**

Grade 10

Grade 11

Grade 12

1st year university

2nd year university

3rd year university

4th year university

**\* 27. Enter the Last letter of mother's name; Age of mother; First letter of your name; Year of father's birth (yy); Last letter of father's name. (x / ##/ x / ## / x)**

## Appendix F. Self-Efficacy and Mindset Questionnaire

I understand the purpose and intentions of this survey and I provide consent to Stephanie Palazzolo to utilize my anonymous results in her Master's thesis research towards the fulfillment of her Master's degree in Education at the University of Windsor.

This study has been cleared by the Research Ethics Board at the University of Windsor.

NEXT

-Enter the Last letter of mother's name; Age of mother; First letter of your name; Year of father's birth (yy); Last letter of father's name. (X ## X ## X)

-What grade(s) did you teach?

-What subject in science did you teach?

-How did you find the level of difficulty when teaching science?

-How did you feel while teaching science?

-To what degree was science challenging? Please elaborate.

-Rate your childhood science-learning experience. What impact did that have in further studies in science?

-What do you think affects student learning?

-How does mindset affect you?

-To what degree does your mindset affect your students?

-How does self-efficacy affect you?

-To what degree does your self-efficacy affect your students?

-What was the factor that influenced your teaching the most in the first year of the B.Ed program?



## VITA AUCTORIS

NAME: Stephanie Palazzolo

PLACE OF BIRTH: Windsor, ON

YEAR OF BIRTH: 1991

EDUCATION: Vincent Massey Secondary School, Windsor, ON,  
2009

University of Windsor, B.Sc. [H], Windsor, ON,  
2013

University of Windsor, B.Ed., Windsor, ON, 2014

University of Windsor, M.Ed., Windsor, ON, 2016