ABSTRACT

CONNECTED KNOWLEDGE IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) EDUCATION

By

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This study investigated the learning preferences of female students enrolled in prerequisite math classes that are gateway to chemistry, engineering, and physics majors at a 4-year public university in southern California. A gender gap exists in certain Science, Technology, Engineering, and Math (STEM) disciplines; this gap may be exacerbated by pedagogies that favor males and make learning more difficult for females. STEM-related jobs were forecast to increase 22% from 2004 to 2014. According to the U.S. Department of Labor, Women's Bureau, only 18.8% of industrial engineers are female. From 2006 to 2011, at the institution where this study took place, the percentage of females who graduate with a Bachelor of Science in Engineering was 16.63%. According to the National Science Foundation, in 2010 there were 1.569 million "Engineering Occupations" in the United States, of which only 200,000 (12.7%) were held by females. STEM professions are highly paid and prestigious; those members of society who hold these positions enjoy a secure financial and societal place.

This study uses the *Women's Ways of Knowing*, *Procedural Knowledge: Separate and Connected Knowing* theoretical framework. A modified version of the Attitudes Toward Thinking and Learning Survey was used to assess student's pedagogical preference. Approximately 700 math students were surveyed; there were 486 respondents. The majority of respondents (*n* = 366; 75.3%) were STEM students. This study did not find a statistically significant relationship between gender and student success; however, there was a statistically significant difference between the learning preferences of females and males. Additionally, there was a statistically significant result between the predictor variables gender and pedagogy on the dependent variable student self-reported grade. If Connected Knowledge pedagogies can be demonstrated to provide a significant increase in student learning, and if the current U.S. educational system is unable to produce sufficient graduates in these majors, then it seems reasonable that STEM teachers would be willing to consider best practices to enhance learning for females so long as male students' learning is not devalued or diminished.

CONNECTED KNOWLEDGE IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) EDUCATION

A DISSERTATION

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In Partial Fulfillment

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What a journey this has been! I would have never thought that I would be where I am today, but here I stand at the finish line of academic achievement, having earned a doctoral degree from what I would consider a prestigious university. Thanks to all those individuals who made this achievement possible; I'll likely miss someone, but I will do my best to mention them all.

To my parents: I am the result of their diligence. The love they poured out and the patience they exercised allowed me the space to experiment, and I am certain that my strong self-confidence results from the security that I experienced growing up. In my mind, my dad has always been a pillar of honesty and integrity. His example blends so nicely with my Christian faith, which teaches me to always do what is right no matter the cost, to work hard and never look for a handout, to say thank you and please, to not think of myself as better than another; and so many other things like these. My mother lavished me with love and acceptance, at times a bit too much; and importantly, she was an avid reader. As a young child, I watched her read and emulated her. Much of my success can be attributed to my love for reading. Like my mother, sometimes my love for reading can get me in trouble. Others think that I am not relaxing because I may be reading something. "Relax, Richard, enjoy yourself," they might say. What they may not realize is that reading is relaxing to me; it does not matter what I am reading; with few exceptions, I will read just about anything. The love that I express toward many of those close to me is a direct reflection of the love I was shown growing up. Certainly, the love and acceptance that I feel from God contributes to this attribute in me as well.

My wife is an amazing person. We have been married since 1982; she is my high school sweetheart, my better half, my helpmate, and my completer. The patience and space that she has allowed me have been absolutely incredible; she is the epitome of the word *patience*. Without her love and support, it would have been impossible for me to achieve just half of my accomplishments. Her hard work and loving guidance have allowed me the space to succeed. It is she who watched our children when I went to class; she is the one who took on extra responsibilities so that I could pursue my academic goals; it is she who took on a disproportionate amount of the parenting responsibilities. My success is directly tied to her willingness to give of herself in our relationship, and I love her very much.

I want to mention my children here, too. Through the years I have felt conflicted. I believed that I was setting an example for them that education is important, but my educational pursuits often prevented me from spending enough time with them. I would do my best to be at all the important events: ball games, plays, special events; however, I often felt that I was compromising my relationship with them with my academic pursuits. Long ago, when I was a young father, one of the books I read was one on parenting by Edwin Luis Cole. The point that stayed with me and guides me to this day reads something like this (paraphrased): On your death bed you will not remember how much money you made, or how much you achieved in life, or how important your position or status was. What you will remember is your loved ones and the meaningful times you all spent together. While this sentiment is not verbatim, it does capture the main point: that all my loved ones, both family and friends, have always been most important to me. While my actions may at times have seemed to reflect otherwise, this has been my goal for years. To my children—Jamie, Robin, Erin, and Danielle: I want to say thank you to each of them for their contribution to my life. They mean the world to me, and I love them all more than I can say.

The Educational Leadership Program at California State University, Long Beach, was a blast. I met some wonderful people there: Alex Ballan, Stacey Benuzzi, Erin Broun, Dan Bryan, Matt Cabrera, Paul Creason, Monica Cole-Jackson, Jassiel Dominguez, Chelena Fisher, Stephen Glass, Ken Kelly, Mon Khat, Jennifer Kolb, Keeley Lewis, Carlos Loza, Jeanette Manduena, Lakyshia Perez, Courtney Robinson, Mike Trimmell, Duncan Sutton, Betty Ta, and Chandi Wood (I hope I didn't miss anyone). The cohort model makes for a great method of support and friendship and is much like a family; it was a wonderful experience! Each of them taught me something; each of them contributed to my learning, and I am a better person because of them.

The professors in the Educational Leadership Program were also amazing: Brandon Gamble, Heidi Gilligan, Don Haviland, Simon Kim, Angela Locks, Hiromi Masunaga, John Murray, Karen Nakai, Jonathan O'Brien, Anna Ortiz, Jim Scott, Linda Symcox, Bill Vega, and Richard Pagel (our guest lecturer in the Policy class). They are an incredible group of people, and I cannot think of a time when I was not challenged in some way. The challenge was not always academic; indeed, the growing was often social or professional. The program's emphasis on social justice requires an individual to constantly reevaluate his or her beliefs. While in the beginning, it was difficult to reconcile my conservative political and religious views with sometimes progressive and liberal thoughts, I believe that the two can coexist. In fact, I know that they can because they do in me. I did not have to compromise either to know and understand both, and doing so has made me a better person. Although every professor had his or her own special quality, there were some exceptional ones: Dr. Symcox was the perfect mix of mother figure and academic genius; Dr. Murray was much the same (minus the mother figure, of course). Dr. Murray was always enlightening, and I was very thankful to have him as my dissertation chair.

Finally, a special word of thanks to my dissertation committee—John Murray, Shuhua An, and Laura Forrest: They are all amazing! I would often think how lucky I was to have such a group of scholars as my committee. Each of them was selected based on strict criteria, and I was so lucky to get my first choice. Dr. Murray was selected because of his decades of experience; Dr. An was selected for her expertise in math education (later I would find out that she was also very much aligned with my interest in gender); and Dr. Forrest was selected for her knowledge about gender equity. Each of them contributed so much to the dissertation process, and I cannot thank them enough. My dissertation is largely a result of their guidance. Their combined expertise in their respective fields of expertise combined helped to make what I believe is a sound and targeted dissertation document that can hold its own in the research arena.

In addition to my committee members, I must not neglect to mention Amy Jennings. Dr. Jennings was hired by the Educational Leadership Department to assist with the quantitative analysis of students' data, and in this regard, Dr. Jennings was irreplaceable. If I have a criticism of the EdD program, it would be its pace. The fast pace of the program does not allow, in my opinion, the opportunity to fully comprehend the material initially. It is only after allowing some time that the material becomes relevant and usable. Such was the case for me with the research classes. While they were taught by very able individuals, the content was so quickly learned that I was unable to use it properly until later. This is where Dr. Jennings excelled in that she provided the targeted, research-based guidance on what analysis would best serve my data and research questions. Dr. Jennings was extremely helpful, and I will always remember her.

It is my hope that this dissertation will make a difference in the lives of females who just cannot figure out why they are not as successful as their male counterparts in certain math and science disciplines. It is to these individuals, the females in science, technology, engineering, and mathematics (STEM) majors, that I dedicate this dissertation. May this dissertation bring light to them as they seek to understand their situation in the STEM classroom, and may policymakers use this dissertation as a springboard toward equity in STEM education.

It seems fitting to me to end this acknowledgment with a quote from the bible. While I have many favorite verses that I was perusing, the one that seemed to speak to me was Psalm 3. It speaks of King David during a difficult time in his life. King David had a special relationship with God. I, too, often feel a special relationship with God; and while I do not feel threatened in any way, the words of Psalm 3 seem apropos:

Lord how are they increased that trouble me; many are they that rise up against me; many there be which say of my soul, “There is no help for him in God.” Selah. But Thou O Lord art a shield for me, my glory and the lifter of mine head. I cried unto the Lord with my voice and He heard me out of His holy hill. Selah. I laid me down and slept; I awaked for the Lord sustained me. I will not be afraid of ten thousands of people that have set themselves against me round about. (Ps. 3:1-6 [NKJV])

CONTENTS

Page

ACKNOWLEDGMENTS iii

TABLES xi

FIGURES xii

CHAPTER

1. INTRODUCTION 1

    The Shortage of STEM Professionals 1
    Problem Statement 5
    Purpose Statement 6
    Research Questions 6
    Theoretical Framework 6
    Operational Definitions 10
    Assumptions 13
    Limitations and Delimitations 13
    Significance of the Study 13
    Chapter Summary 14

2. LITERATURE REVIEW 15

    Background 15
    STEM and Gender 18
    STEM Education 30
    Pedagogical Methods 32
    Conclusion 35
    Chapter Summary 36

3. METHODOLOGY 37

    General Methodological Design 37
    Population 38
    Sample 39
    Instrument 42
    Data Preparation 45
    Data Collection 47

CHAPTER Page

Protection of Participants 48
Reliability and Validity 50
Data Analysis 51
Chapter Summary 52

4. FINDINGS 53

Data Analysis 53

5. SUMMARY OF THE STUDY 62

Findings 65
Discussion 67
Limitations of the Research Study’s Results 69
Recommendation for Practice 70
Recommendation for Policy Change 71
Recommendations for Further Study 71
Conclusion 72

APPENDICES 74

A. ATTLS INSTRUMENT 75

B. LETTER TO MATH PROFESSORS 80

C. SCRIPT 82

D. INFORMED CONSENT 84

E. SPEARMAN RHO CORRELATIONS 87

REFERENCES 96

TABLES

TABLE Page

1. Top 15 Traditionally (Female-Dominated) Detailed Occupations, by Women as a Percentage of Total Employed and Median Weekly Earnings (2013 Annual Averages) 4

2. Nontraditional (Male-Dominated) Engineering Occupations Held by Women as a Percentage of Total Employed and Median Weekly Earnings (2013 Annual Averages) 5

3. Gender Distribution of the Sample 39

4. Age Distribution of the Sample 40

5. Ethnic Distribution of the Sample 41

6. Students' Self-Report of Disabilities Affecting Math Capabilities 41

7. Majors Reported by Respondents 43

8. Results of Spearman Rank Order Correlation Tests of Association 55

9. Results of First Chi-Square Tests 56

10. Results of Second Chi-Square Tests 57

11. Results of *t* Tests for Significance of Association Between Connected Knowledge and Separate Knowledge 58

FIGURES

FIGURE Page

1. Women as a percentage of total employed in selected occupations, 1985–2012 annual averages 2

2. Bachelor of Science College of Engineering graduates by gender for academic years 2006/2007 to 2010/2011 3

3. Bachelor's degrees awarded to men and women in STEM fields of study, 1977–2011 22

4. Measures of gender segregation over time, for bachelor's degree recipients 23

5. Standardized math performance as a function of standardized mothers' gender stereotypes and stereotype threat 29

6. Choosing the correct statistical test 52

CHAPTER 1

INTRODUCTION

According to numerous researchers a gender gap exists in the science, technology, engineering, and math (STEM) disciplines (Else-Quest, Hyde, & Linn, 2010; Shah, 2003; Upadhyay & DeFranco, 2008; Zohar, 2006). The gap is one of achievement, as reflected in grades and persistence in STEM majors (Curren, 2006; Else-Quest et al., 2010; Zohar, 2006). Many researchers believe that in some cases, the gap begins as early as elementary school, is present in many middle school-age girls and boys, and solidifies in most high school-age young women and men (Akcay & Yager, 2010; Upadhyay & DeFranco, 2008). This gap may be exacerbated by pedagogies that favor males and make learning more difficult for females (Blumberg, 2007; Finson, Thomas, & Pedersen, 2006; Zohar, 2006).

The Shortage of STEM Professionals

The world is becoming increasingly dependent on people who possess STEM-related skills and abilities. Indeed, in 2007 the U.S. Bureau of Labor Statistics (BLS) estimated that nationwide, STEM-related jobs would increase by 22% from 2004 to 2014. According to the U.S. Department of Labor, Women's Bureau (2012), the percentage of females who occupy the industrial engineering field is 18.8%. Nationally, there has been a significant rise in female industrial engineers' participation rate from 1985 until today (10.9% in 1985, 17.2% in 2000, and 18.8% in

2012); however, engineering still represents the lowest of all occupations that females participate in (Figure 1).

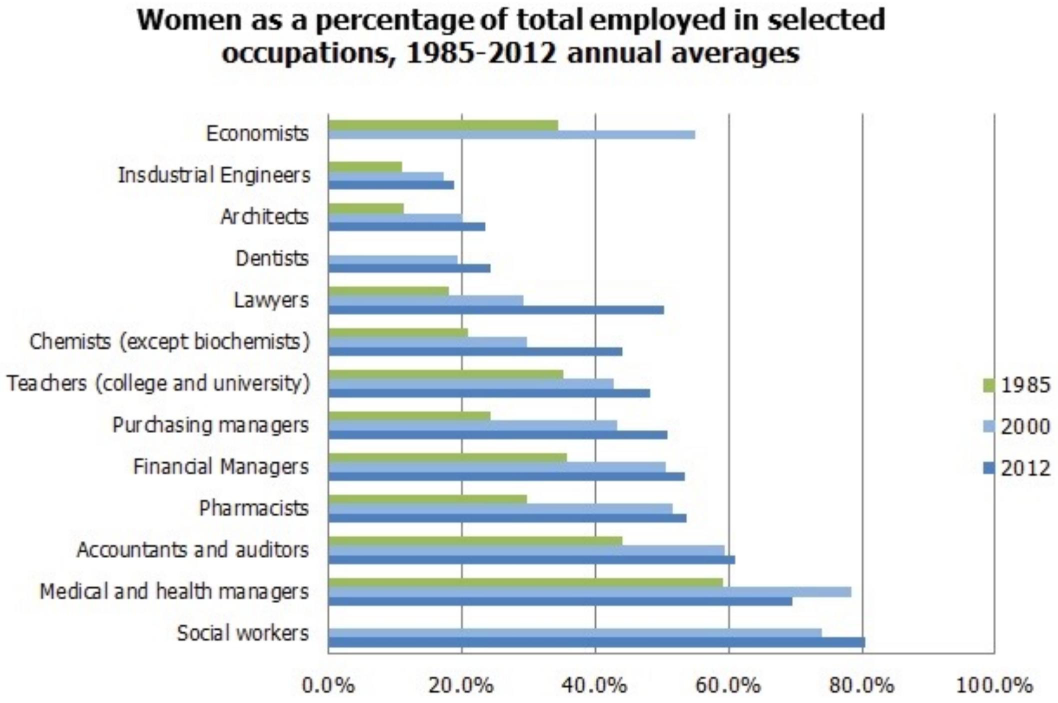


FIGURE 1. Women as a percentage of total employed in selected occupations, 1985–2012 annual averages. Source: *STEM Occupations and Job Growth,* by U.S. Bureau of Labor Statistics, 2007, retrieved from http://www.bls.gov/opub/ted/2007/jun/2k4/art04.htm

From the years 2006 to 2011, at the institution where this study took place, the percentage of females who graduate with the degree Bachelor of Science in Engineering was 16.63%, a percentage representative of national norms (Figure 2; citation withheld to maintain anonymity).

Looked at a different way, Table 1 lists the top 15 female-dominated occupations, with the accompanying gendered differentials in employment percentages and weekly earnings. This is contrasted with Table 2, which lists only

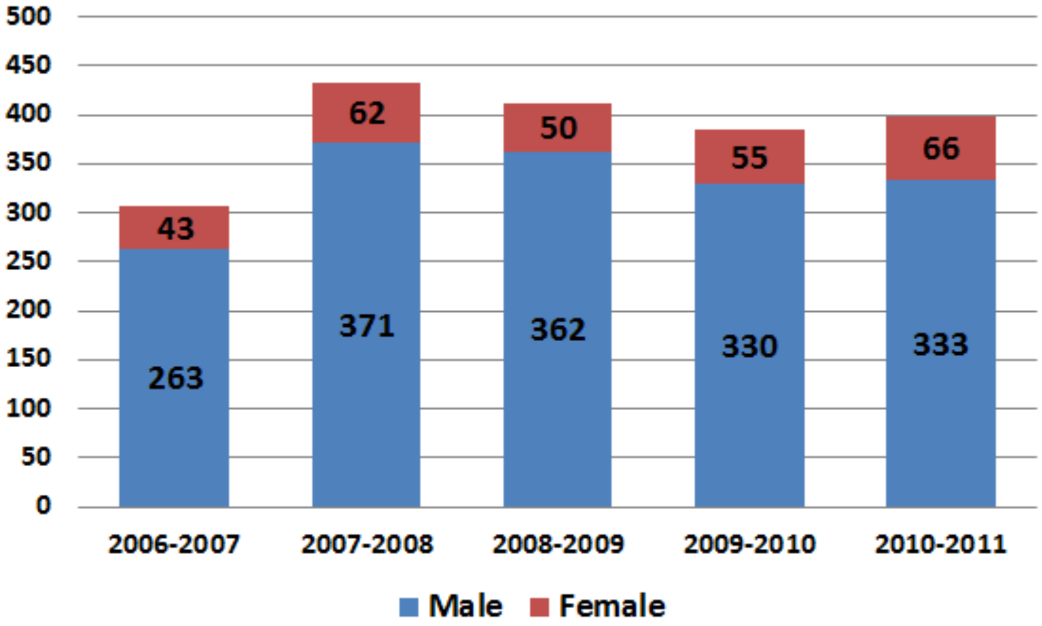


FIGURE 2. Bachelor of Science College of Engineering graduates by gender for academic years 2006/2007 to 2010/2011. (Source withheld to maintain anonymity of the university.)

those occupations that are associated with the field of interest in this study: engineering. When combined, these two tables demonstrate the most recent information regarding females in the so-called hard sciences; females occupy a small percentage of the engineering occupations (from a low of 5.5% to a high of 17.2%) and female-dominated occupations have significantly lower mean pay than engineering occupations: $637.42 mean weekly pay for the top 15 female-dominated occupations compared to $1,565.44 mean weekly pay for engineers listed in Table 2 (U.S. Department of Labor, Women's Bureau, 2013).

According to the National Science Foundation (NSF), in 2010 there were 1.569 million "Engineering Occupations" in the United States, of which only 200,000 (12.7%) were held by females (NSF, 2013, Table 9-19).

TABLE 1. Top 15 Traditionally (Female-Dominated) Detailed Occupations, by Women as a Percentage of Total Employed and Median Weekly Earnings (2013 Annual Averages)

Occupation name	Total employed, both sexes (in thousands)[a]	Women as a percentage of total employed[b]	Median weekly earnings[c] ($)	
			Both sexes	Women
Dental hygienists	184	98.3	1,005	1,011
Preschool/kindergarten teachers	695	97.8	638	624
Medical transcriptionists	52	97.8	-	-
Dental assistants	279	95.7	571	$ 571
Hairdressers, hairstylists, and cosmetologists	786	94.8	488	485
Childcare workers	1,230	94.8	418	418
Secretaries and administrative assistants	2,922	94.4	681	677
Medical assistants	458	94.1	531	523
Word processors and typists	101	94.1	621	607
Speech-language pathologists	137	93.4	1,218	1,191
Medical records and health information technicians	88	92.4	612	595
Payroll and timekeeping clerks	156	92.4	731	727
Receptionists and information clerks	1,326	92.2	536	527
Nurse practitioners	126	91.8	1,615	1,539
Billing and posting clerks	497	91.7	637	629

Note. From *Traditional and Nontraditional Occupations,* by U.S. Department of Labor, Women's Bureau, 2013, retrieved from http://www.dol.gov/wb/stats/nontra_traditional_occupations.htm

[a] Total employed are 2013 annual averages for all people employed (includes part-time and self-employed). [b] Women as a percentage of total employed are 2013 annual averages for all people employed (includes part-time and self-employed). [c] Median weekly earnings are 2013 annual averages for full-time wage and salary workers only; dash indicates no data or base is less than 50,000. Data for men's earnings were not available or base was less than 50,000 employees for most traditional occupations.

TABLE 2. Nontraditional (Male-Dominated) Engineering Occupations Held by Women as a Percentage of Total Employed and Median Weekly Earnings (2013 Annual Averages)

Occupation name	Total employed, both sexes (in thousands)[a]	Women as a percentage of total employed[b]	Median weekly earnings (both sexes)[c]
Aircraft pilots and flight engineers	135	5.5	$1,845
Mechanical engineers	327	7.2	1,496
Electrical and electronics engineers	300	8.3	1,522
Computer hardware engineers	90	9.2	1,507
Civil engineers	360	12.1	1,373
Aerospace engineers	144	12.2	1,865
Engineers, all other	398	14.4	1,528
Chemical engineers	61	15.6	1,568
Industrial engineers, including health and safety	190	17.2	1,385

Note. From *Traditional and Nontraditional Occupations,* by U.S. Department of Labor, Women's Bureau, 2013, retrieved from http://www.dol.gov/wb/stats/nontra_traditional_occupations.htm

[a] Total employed are 2013 annual averages for all people employed (includes part-time and self-employed). [b] Women as a percentage of total employed are 2013 annual averages for all people employed (includes part-time and self-employed). [c] Median weekly earnings are 2013 annual averages for full-time wage and salary workers only; dash indicates no data or base is less than 50,000. Data for women's earnings were not available or base was less than 50,000 employees for most nontraditional occupations, earnings report on this table are totals for both sexes.

Problem Statement

The problem investigated in this study was low female participation rates and/or persistence in certain STEM courses-majors, predominantly but not exclusively engineering and physics.

Purpose Statement

The purpose of this study was to investigate the pedagogical preferences of STEM students in math courses that are prerequisites to engineering, physics, and chemistry courses at a 4-year university in southern California.

Research Question

Do STEM students prefer to learn with one pedagogical method more than another?

Theoretical Framework

To increase female engineering participation rates and thus address the U.S. shortages of engineers, researchers have sought to understand those elements in the teacher-learner exchange that affect, both positively and negatively, learner outcomes. One approach that appears to have demonstrated increased female participation rates is called *connected knowledge* (Belenky, Clinchy, Goldberger, & Tarule, 1986). According to MoodleDocs (2005),

> [Connected learners are] more sensitive to other people. [They are] skilled at empathy and tend to listen and ask questions until [they] feel [they] can connect and "understand things from [others'] point of view." [They] learn by trying to share the experiences that led to the knowledge [that they found] in other people. When talking to others, [they] avoid confrontation and will often try to help the other person if [they] can see a way to do so, using logical suggestions. [The Connected learner] is a very connected knower. (para. 5)

Connected knowledge (Belenky et al., 1986) is a philosophy of instruction that Zohar (2006) has demonstrated significantly reduces the gender gap in understanding course material, specifically course material in STEM disciplines. Other terms have been or are being used to express compatible pedagogies, among them *inquiry-based* and *Piagetian constructivism* (Mulhall & Gunstone, 2012). An example of connected knowledge pedagogy would be informs the student of the process, as well as the many related aspects of the process. For example, a teacher using connected knowledge uses his or her experiences, other lessons the student has already learned that relate to the subject matter, common knowledge, and so on, to present the process (Belenky et al., 1986). The use of connected knowledge pedagogies results in two primary outcomes: Both genders note an increase in learning and females experience an increase in connectedness with the learning process (Zohar, 2006). According to Blumberg (2007) and Zohar (2006), when connected learning is used in classroom instruction, both male and female students benefit; both also experience a sense of accomplishment.

The antithesis of connected knowledge is separate knowledge. According to MoodleDocs (2005),

> Separate learners like to remain as "objective" as possible, without including feelings and emotions. When in a discussion with other people who may have different ideas, [they] like to defend [their] own ideas, using logic to find holes in [their] opponent's ideas. [Separate learners are] critical of new ideas unless they are proven facts from reputable sources such as textbooks, respected teachers, or [their] own direct experience. (para. 4)

As a point of contrast, separate knowledge (Belenky et al., 1986) has been demonstrated to produce a less positive learner outcome (Marrs & Benton, 2009; Zohar, 2006). Other terms that have been use to describe separate knowledge include *analytical, critical, detached*, and *objective* (Galotti, Clinchy, Ainsworth, Lavin, & Mansfield, 1999). These terms describe disconnected components of the whole being treated separately; for example, a teacher describing a specific process without linking the process to the multifaceted aspects to which it naturally connects (Belenky et al., 1986; Zohar, 2006). A body of research demonstrates that separate knowledge is the more commonly used pedagogy in STEM education (Opdenakker & Van Damme, 2006; Stipek, Givvin, Salmon, & MacGyvers, 2001; Zohar, 2006).

This study used the Women's Ways of Knowing theoretical framework (Belenky et al., 1986). Belenky et al. (1986) ascribed the foundation of their theory to Gilligan's (1982) work described in *In a Different Voice*. Gilligan (1982) ascribed the foundation of her work to Perry's (1999) *Forms of Intellectual and Ethical Development in the College Years: A Scheme.*

Belenky et al. (1986; Belenkey, Clinchy, Goldberger, & Tarule, 1997) presented a qualitative analysis of women's voices. They resisted the notion that women's voice is singular but, while uniquely feminine, it is also diverse. They emphasized that it is uniquely different from the male voice. The researchers illustrated this point in the following way:

> Women constructivists show a high tolerance for internal contradiction and ambiguity. They abandon completely the either/or thinking. . . . They recognize the inevitability of conflict and stress and, although they may hope to achieve some respite, they . . . "learn to live with conflict rather than talking or acting it away." They no longer want to suppress or deny aspects of the self in order to avoid conflict or simplify their lives. (Belenky et al., 1997 p. 137)

Belenky et al. (1986) presented a subtheory defined as *connected knowing and separate knowing* or *connected knowledge and separate knowledge*; it is this portion of their work that formed the lens or framework for this study. An example of two dichotomous pedagogical theories, connected knowledge and separate knowledge, are offered.

Connected knowledge informs the student of the process, as well as the many related aspects of the process. For example, a STEM teacher utilizing connected knowledge pedagogies might introduce a topic, then briefly discuss the history of the topic, how the topic relates to the student's present or future career, write the problem on the chalkboard, solve the problem, ask for feedback from the student on how the problem was solved, and ask the student for an example of where the topic could be used to solve a real-life situation. By contrast, separate knowledge is described as disconnected components of the whole. For example, a STEM teacher utilizing separate knowledge pedagogies might write a problem on the chalkboard and solve the problem, without explaining how the student might use the problem currently or in a future career; how the problem might be used to solve a real-life situation in industry, society, or biology; or how the problem was solved. In many cases the separate knowledge teacher solves the problem on the chalkboard, turns to the class and asks, "Any questions?" to end the discussion topic.

Since the initial work by Belenky et al. (1986) on connected knowledge and separate knowledge, several authors have applied the theory to their research. Among the most prolific of these authors is Anat Zohar (2004a, 2004b, 2006). Another author who has developed the connected knowledge and separate knowledge theory is Karen Zuga (1999). The work of Zohar and Zuga is especially relevant due to their focus on STEM education, a central focus of the research question in the current study. Belenky et al. (1986, 1997), Zohar (2004a, 2004b, 2006), Zuga (1999), and others have documented that most STEM education is taught from a distinctly separate knowledge perspective.

Belenky et al. (1986, 1997) enumerated differences between genders in the mental processing of information. These differences are posited to make learning in the STEM disciplines more difficult for females because the STEM disciplines are especially predisposed to the use of separate knowledge pedagogies, the antithesis of the connected knowledge learning style most commonly used by females (Akcay & Yager, 2010; Finson et al., 2006; Mulhall & Gunstone, 2012; Zohar, 2006).

Operational Definitions

Connected Learning

> (Connected Knowing; connected knowledge; and so on) [Connected learners are more sensitive to other people. [They are] skilled at empathy and tend to listen and ask questions until [they] feel [they] can connect and "understand things from [others] point of view." [They] learn by trying to share the experiences that led to the knowledge [that they found] in other people. When talking to others, [they] avoid confrontation and will often try to help the other person if [they] can see a way to do so, using logical suggestions. [The connected learner is] a very connected knower. (MoodleDocs, 2005, para. 5)

Constructivism

Constructivism is a theory about how people learn; it is based on observation and scientific study. The theory holds that people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences. When something new is encountered, it must be reconciled to previous ideas and experience, perhaps changing beliefs or discarding the new information as irrelevant. In any case, people are active creators of their own knowledge. To do so, they must ask questions, explore, and assess what they know (Magar Matsuoka, n.d., para. 1).

Formulaic Pedagogies

Pedagogies that are "made according to a formula; composed of formulas: a formulaic plot; being or constituting a formula: formulaic instructions" ("Formulaic,' 2015).

Gender Disparity

“The differences in the status, power and prestige women and men have in groups, collectivities and societies” (“Gender Inequality,” 2014).

Gender Fair

“Expanding the classic feminist conception of connected knowledge to embrace the meaning of understanding according to the current cognitive and educational literature” (Zohar, 2006, p. 1592).

Gender Gap

“The differences between women and men, especially as reflected in social, political, intellectual, cultural, or economic attainments or attitudes” (“Gender Gap,” 2015).

Inquiry-Based Pedagogy

Inquiry-based learning is an approach to teaching and learning that places students’ questions, ideas, and observations at the center of the learning experience. Educators play an active role throughout the process by establishing a culture where ideas are respectfully challenged, tested, redefined and viewed as improvable, moving children from a position of wondering to a position of enacted understanding and further questioning (Scardamalia, 2002).

Middle School

A school for children that usually includes Grades 5 to 8 or 6 to 8, for children between the ages of 8 and 12 or 9 and 13 (“Middle School,” 2015).

Pedagogy

"The function or work of a teacher; teaching. The art or science of teaching; education; instructional methods" ("Pedagogy," 2015).

Separate Learning

> Also termed separate knowing, separate knowledge, and so on.
>
> The Separate learner likes to remain as "objective" as possible without including feelings and emotions. When in a discussion with other people who may have different ideas, [he or she] likes to defend ideas, using logic to find holes in opponent's ideas. [The Separate learner] is critical of new ideas unless they are proven facts from reputable sources such as textbooks, respected teachers or [his or her] own direct experience. (MoodleDocs, 2005, para. 4)

STEM Education

> Science, technology, engineering, and math (STEM) education is used to identify individual subjects, a stand alone course, a sequence of courses, activities involving any of the four areas, a STEM-related course, or an interconnected or integrated program of study. (California Department of Education, n.d., para. 1)

Student Self-Reported Grade

> This study used student-self reported grade as its dependent variable. Additionally, the survey was administered in the ninth week of a 16-week semester. Ninety-seven percent of students reported a passing grade in the study; it is very unlikely that these are representative of actual student grades.

Traditional (Absorptionist) Pedagogy

> The overall picture painted by researchers of traditional teaching practices in both science and the science disciplines is one in which knowledge of facts and processes is valued over intellectual engagement with ideas. Such an approach is linked to an absorptionist view of learning and a discovery view of the development of scientific knowledge. (Mulhall & Gunstone, 2012, p. 432)

Assumptions

In this study it was assumed that survey respondents were truthful when responding to survey items. It was also assumed that the survey reached the appropriate population of students.

Limitations and Delimitations

Because this study was conducted at a single American university in southern California, its generalizability to other universities is limited. Additionally, since the study is of the math segment of the STEM population, generalizability to broader STEM courses and majors is limited. Finally, since the data was collected in the ninth week of a 16-week semester, student's self-reported grades were likely not representative of their actual grades in the course; this thought is furthered by the large percentage of students (97.0%) who believed they would pass the class with a C or better.

Significance of the Study

This study increases what is known about female learning preferences in math classes that are prerequisite to engineering, physics, and chemistry majors at a public 4-year university in southern California. There is a shortage of engineering professionals in the U.S. labor force. According to the U.S. Department of Labor, Women's Bureau (2012), the percentage of females who occupy the industrial engineering field is 18.8%. From the years 2006 to 2011, at the institution where this study took place, the percentage of females who graduate with the degree Bachelor of Science in Engineering was 16.63% (citation withheld to maintain anonymity). According to the NSF, in 2010 there were 1.569 million "Engineering Occupations" in the United States, of which only 200,000 (12.7%) were held by females (NSF, 2013, Table 9-19). These statistics confirm that a low female participation rate in engineering contributes to the shortage of these STEM professionals nationally.

If female learning preference is determined to affect their participation rates in engineering courses and majors, and if connected knowledge pedagogy can be demonstrated to provide a significant increase in student learning for women (Else-Quest et al., 2010; Sabah & Hammouri, 2010; Upadhyay & DeFranco, 2008; Zohar, 2006), then it seems reasonable that STEM teachers would be willing to consider modifying their teaching style to enhance learning for females so long as male students' learning is not devalued or diminished.

Chapter Summary

The salient points of this introduction are as follows:

1. The problem of female participation rates in certain STEM majors is longstanding, persistent, and multifaceted.

2. The longer the problem remains, the greater the deficit of STEM professionals grows.

3. The lack of sufficient STEM professional stymies technological innovations that depend on STEM professionals (e.g., advances that lead to increased quality of life; meeting the global demand for sufficient food, clean water, effective health care; environmentally responsible energy production).

CHAPTER 2

LITERATURE REVIEW

Background

Chapter 1 introduced the lack of female participation and persistence in certain STEM majors and the resultant lack of participation in STEM occupations. Often referred to as the "hard sciences," these majors and careers are primarily chemistry, engineering, physics, and similar occupations. This dissertation study focuses on the gender gap in STEM education. It is hypothesized that pedagogy plays a key role in promoting, strengthening, or otherwise undergirding the gap. Furthermore, it is hypothesized that certain pedagogies can be beneficial in reducing the gap, making learning certain STEM topics more equitable between the genders.

This chapter's contains three main sections: (a) the shortage of STEM professionals, including students' choice and persistence in STEM majors; (b) STEM and gender, including female student participation in STEM, the gender gap in STEM, the intersectionality of gender differences in math performance, stereotypes and stereotype threat, and a gender-fair education; and (c) STEM education, including the nature of STEM, STEM educators, pedagogical methods, connected knowledge, and separate knowledge.

This chapter consists of a review of the literature regarding females in STEM. The chapter contains a discussion of structural roadblocks faced by females in bridging the STEM education gap (e.g., the pedagogical method used in the majority of STEM classes). The chapter also addresses efforts to minimize the gender gap to place learning the hard sciences in parity for both genders (e.g., female role models and pedagogical methods that are equally easy for both genders). The discussion begins by exploring what scholars have said about the shortage of STEM professionals in the United States.

The Shortage of STEM Professionals

The world is becoming increasingly dependent on people who possess STEM-related skills and abilities. In 2007, the BLS estimated that STEM-related jobs in the United States would increase by 22% from 2004 to 2014 (BLS, 2007); however, there are insufficient numbers of U.S.-born individuals to fill these jobs. Therefore, legislation was enacted that provides special work visas for foreigners who possess specific STEM skills. Since 1965, the United States has offered temporary work visas, called H1B visas, to foreigners to provide the American work force with sufficient numbers of specially trained workers (U.S. Citizenship and Immigration Services, 2014). The purpose of the H1B visa is as follows:

> The regulations define a "specialty occupation" as requiring theoretical and practical application of a body of highly specialized knowledge in a field of human endeavor including, but not limited to, architecture, engineering, math, physical sciences, social sciences, medicine and health, education, law, accounting, business specialties, theology, and the arts. H1B work authorization is strictly limited to employment by the H1B sponsoring employer. (Cornell University Law School, n.d., 8 U.S. Code §1101)

Each year, 65,000 H1B visas are granted for undergraduate-level professional positions; an additional 20,000 are granted for graduate-level professional positions (U.S. Citizenship and Immigration Services, 2014). Even with an influx of 85,000 foreign-born STEM professionals into the U.S. labor force each year, the need surpasses the supply.

Student's Choice and Persistence in STEM Majors

According to the NSF (2013), from 2003 to 2011 the mean number and percentage of employed persons in the United States who were engineers was 1,876,000 (1.32% of 141,484,889 employed persons). From 2004 to 2009 the U.S. Department of Education (2013) conducted a study analyzing various aspects of STEM postsecondary students. They reported that the percentage of bachelor's degree seekers who enrolled in the STEM field of math was 2% and in physical sciences was 3%. Although a small percentage of bachelor's degree seekers choose the hard sciences, the attrition rate of these students is less than that of non-STEM majors (28% for STEM majors compared to 48% for non-STEM majors; U.S. Department of Education, 2013, p. iv). Even with a lower attrition rate, the United States is still experiencing a shortage of STEM professionals. Among the many proposals to increase the number of STEM professionals are increased efforts to reduce attrition among STEM students. In 2012, the President's Council of Advisors on Science and Technology stated,

> Producing sufficient numbers of graduates who are prepared for science, technology, engineering, and mathematics (STEM) occupations has become a national priority in the United States. To attain this goal, some policymakers have targeted reducing STEM attrition in college, arguing that retaining more students in STEM fields in college is a low-cost, fast way to produce the STEM professionals that the nation needs. (U.S. Department of Education, 2013, p. iii)

However, this alone will not produce the needed number of STEM professionals to continue the U.S. economic growth. Another proposed solution is to increase the number of females entering STEM fields.

STEM and Gender

While there are more females in STEM majors today than in the past, the majority of society views most STEM disciplines as male domains (Angell, Guttersrud, Henriksen, & Isnes, 2004; Britner, 2008; Else-Quest et al., 2010; Zohar, 2006). Females outnumber males in the life sciences (biology and chemistry) but males outnumber females in math and physics (Zohar, 2004b).

Female Student Participation in STEM

Female performance in math and similar STEM majors such as chemistry, engineering, and physics has improved and is essentially parallel with the performance by males (Hill, Corbett, St. Rose, & American Association of University Women, 2010; Tomasetto, Alparone, & Cadinu, 2011); however, female participation rates in these same majors have not increased (Betz & Sekaquaptewa, 2012). The most recent data from the NSF (2011) demonstrated that female participation and graduation with a bachelor's degree in the most "male" areas of STEM (physical sciences and math) is declining. From 2002 until today, the number of females who graduated with a bachelor's degree in these two fields has declined from a high of 48% in 2002 to 38% today (NSF, 2011). Why do the numbers of female STEM graduates in the predominately male arenas resist change? The following narrative explores possible explanations for this condition.

Betz and Sekaquaptewa (2012) presented findings regarding middle school (junior high school) girls and female role models. The findings from two studies (N = 144 and N = 92) at one unidentified school site, presumably in the United States, confirmed the authors' assertion that the reasons for female-STEM interactions are multifaceted and complex. Their research focused on math performance deltas from the perspective of gendered stereotypes and the willingness of students to view themselves as role models. Based on their literature review, the researchers hypothesized either no interaction or a negative interaction for female role models and positively encouraging female middle school students toward STEM success. Some of the example role models investigated in their studies were posters of "geeky female (and male) computer scientists," "Mattel's Computer Engineer Barbie," and the book "*Math Doesn't Suck: How to Survive Middle School Math Without Losing Your Mind or Breaking a Nail''* by McKellar and Blasutta (2008). Their findings confirmed their literature review and hypothesis; female middle school students did not connect positive STEM female role models to their own STEM success.

Milgram's (2011) findings are the antithesis of those reported by Betz and Sekaquaptewa (2012). Milgram asserted that female role models are among the most influential factors that can positively influence female students to participate in STEM fields. Milgram primarily used two types of role models: posters portraying females in STEM occupations and female professionals giving presentations. Perhaps the age range of Betz and Sekaquapetewa's sample, contrasted with Milgram's sample, could have contributed to this dichotomous result. Milgram's research primarily focused on secondary and postsecondary females, while Betz and Sekaquaptewa focused on middle school students. In either case, these findings are important because, as Rodman's (2010) findings indicated, middle school is the most influential time for girls with regard to future STEM career choices.

Starobin and Laanan (2008) explored the impact of an initiative funded by NSF to increase transfer rates by female engineering students at a community college in Washington. The authors hypothesized that an interrelated support mechanism would increase female student transfers to a neighboring 4-year university's engineering program. The findings supported that coordinated efforts by an interrelated student support mechanism had a positive impact on female engineering student success, as demonstrated by positive attitudes, increased self-confidence, and increased transfer rates to a university. While the results of the study are not generalizable due to the qualitative study method and sample size (*N* = 3), the results provide another option to increase female student participation in certain STEM majors. Starobin and Laanan (2008) and Betz and Sekaquapetewa (2012) agreed that increasing female self-confidence and self-efficacy, or otherwise providing supports to counter stereotypes about female success in STEM, can make a significant impact.

The Gender Gap in STEM

Carrell, Page, and West (2010) and Mann and DiPrete (2013) stated that, while much is still unknown about the gender gap in STEM, reporting what has been tested and found to be insignificant can guide future research or replicate past research with a different framework or perspective. Although decades of research have been conducted exploring the reasons for the gender gap in STEM education and professions, results have been inconclusive.

There have been many rigorous studies regarding the gender gap in STEM education. Mann and DiPrete (2013) compiled 4 decades of data to explore the causes of gendered STEM choices. Carrell et al. (2010) explored the effects of the teacher's gender on female students' math and science performance.

Mann and DiPrete (2013) used 4 decades of national datasets from U.S. high schools to explore reasons for the gender gap in STEM. The datasets contained records for approximately 89,000 students from approximately 4,240 high schools over a 40-year period. In addition to the approximately 89,000 initial participants, in almost every decade one or more follow-up questionnaires were administered to augment the information gleaned from the initial sample. In some cases, three follow-up surveys were conducted in 2-year intervals, making a single decade's dataset actually a compilation of four datasets. Nevertheless, with few exceptions, the results of the analyses did not yield revolutionary conclusions; indeed, the researchers expressed the hope that curriculum might help to identify more of the reasons for the gender gap in STEM education and professions; none of the authors' hypotheses explained the reason for the gender gap.

Figure 3 presents the gendered undergraduate degrees across the 40 years of the study by Mann and DiPrete (2013). While female participation in STEM programs increased during this time, the increase was primarily in the biological and agricultural sciences; participation in engineering, physical sciences, and math showed little change by comparison. For example, in 1977, only 5% of engineering graduates were female, compared to 21% in 2002 (p. 1520). To date, the percentage of female engineering graduates has never reached 25%.

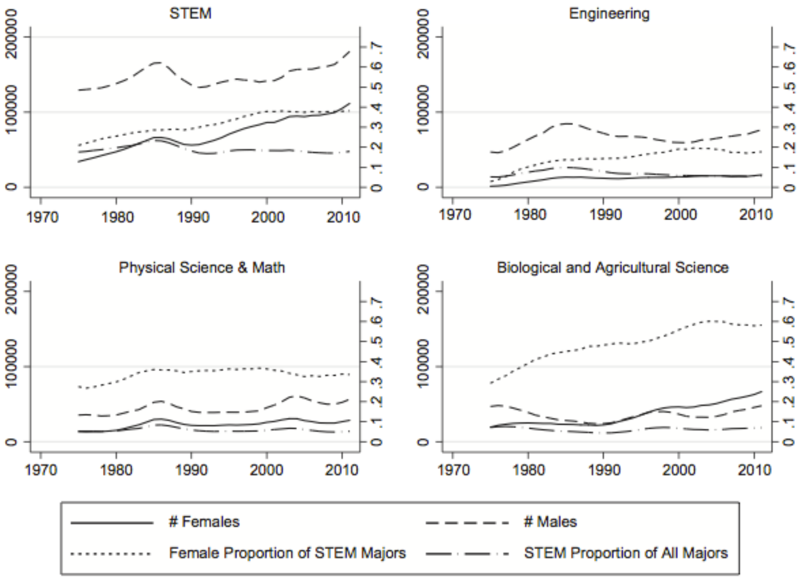


FIGURE 3. Bachelor's degrees awarded to men and women in STEM fields of study, 1977–2011. Source: "Trends in Gender Segregation in the Choice of Science and Engineering Majors," by A. Mann & T. A. DiPrete, 2013, *Social Science Research, 42*, p. 1520.

Figure 4 depicts the changes in gender segregation during the same 40 years. While a significant reduction in gender segregation is clear, there has been little change in the sciences since the mid-1970s; STEM and non-STEM degree recipients remain highly gendered. Mann and DiPrete's (2013) work explored reasons for this gendered outcome, explaining that, in spite of concerted efforts, such as "higher math test scores for females, gendered life goals, work-family compatibility, and extrinsic or intrinsic satisfaction" (p. 1520), the gender gap in certain STEM majors remains. While these findings do not satisfactorily explain the cause of the problem, they partially explain the gender gap. All findings will be explored, although none is claimed to be significant. It is this author's contention that knowing what is not the cause may be as important as knowing what is the cause.

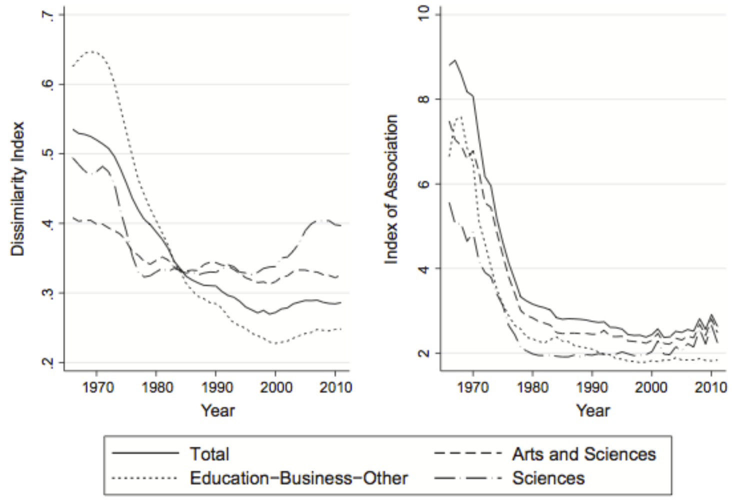


FIGURE 4. Measures of gender segregation over time, for bachelor's degree recipients. Source: "Trends in Gender Segregation in the Choice of Science and Engineering Majors," by A. Mann & T. A. DiPrete, 2013, *Social Science Research, 42*, p. 1522.

The findings reported by Mann and DiPrete (2013) are reviewed here. Finding 1 was that "gender differences in math performance explain only a small fraction of the gap and play even less of a role in accounting for gender-specific trends in the pursuit of STEM majors" (p. 1521). Since math scores that lead to the gendered STEM majors are on parity for females and males (Albano & Rodriguez, 2013; Mann & DiPrete, 2013), this factor does not explain the gendered STEM outcome. Indeed, Tomasetto et al. (2011) found that, when controlling for stereotype threat, gender had little effect on math performance.

Finding 2 was that "using survey questions about twelfth graders' life goals, we find that gender differences in life goals contribute little to understanding the disparity in fields of study" (Mann & DiPrete, 2013, p. 1521). Life goals were categorized by family aspirations and by intrinsic and extrinsic motivations. While the genders held different life goals (females rated family aspiration and intrinsic motivation higher than did males, and males rated extrinsic motivation higher than did females), this factor was not significant in predicting gendered STEM outcomes.

Finding 3 was that "women and men in 4-year colleges differ in the way they link college majors to post-bachelor training, occupations, and their broader educational goals while in school" (Mann & DiPrete, 2013, p. 1521). This means that, when a STEM major has a closely controlled curricular pathway, more men favor it; when a STEM major has a more loosely curricular pathway, more females favor it. STEM majors such as engineering, physical science, and math have highly correlated circular pathways, meaning that a student has little chance to deviate from the prescribed coursework in the program, and STEM majors such as biology and similar life sciences have broader and more loosely correlated coursework pathways. Thus, the person who selects the former (rigid) STEM pathway has, by default, fewer choices in the college experience. This was hypothesized to be a significant predictor in the study; however, such was not the case.

Carrell et al. (2010) conducted a unique study at the United States Air Force Academy (USAFA). This military, highly selective university is unique among private and public 4-year institutions because of the way students receive their classes, course content, and testing methods. At USAFA a common syllabus is used in every common class; the same test and test times are provided for all common classes. A computer program randomly assigns students to classes; students have no choice but to attend the assigned courses. This uniformity in course and content limits variations in participants' college experiences. Experimental designs of this nature produce results with a high degree of validity and reliability. As can be seen in the preceding information, USAFA provides a quantitative researcher's ultimate environment to conduct research, the truest random sample. To verify random assignment Carrell et al. (2010) did the following: "We used resampling methods to construct 10,000 sections drawn from the relevant course and semester and found that the distribution of academic ability by assigned section is indistinguishable from the distribution observed in the resampled sections" (p. 1115).

At the time of the study there were 249 faculty, of whom 47 (19%) were female; approximately 17% of the students at the time of the study were female. The researchers explored the relationship between teacher's gender and student STEM performance. The results showed a highly significant female STEM student to female STEM professor math performance increase. The female students' math performance increase was approximately 10% of a standard deviation, essentially the same value of the nominal gender gap in traditional math classes (p. 1123). Unfortunately, the factor that might have been associated with this female STEM student success were not identified. The researchers tested differences in interaction with professors (as measured by items such as "meeting with professors during office hours"), teaching style in a variable called "value-added," and so on. The tests did not determine whether these were factors in female student to female professor interaction contributed to the increase in math performance by females.

The Intersectionality of Gender Differences in Math Performance, Stereotypes, and Stereotype Threat

Gender differences in math performance, stereotypes, and stereotype threat play roles in female participation, persistence, and the shortage of STEM professionals in the United States. This section explore the reasons for these differences. The section begins with a brief explanation of stereotype threat, then reviews the intersections of gender differences in math performance, stereotypes, and stereotype threat.

Stereotype Threat

The term *stereotype threat* was popularized in 1995 by Steele and Aronson, who wrote about its effect on African Americans. Since that time, the term has been broadened to encompass many groups; as it pertains to this dissertation, it is explored from a gendered perspective. Steel and Aronson (1995) defined stereotype threat as "being at risk of confirming, as self-characteristic, a negative stereotype about one's group" (p. 797). The outcome is a biased toward the threat. Else-Quest et al. (2010) described the gendered phenomenon as follows:

> If girls observe that women in their culture do not become engineers or scientists, they may believe that such careers (and, by extension, STEM subjects) are outside the realm of possibilities for girls and feel anxious about and/or avoid these subjects. (p. 106)

Gender Differences in Math Performance, Stereotypes, and Stereotype Threat

The data concerning gendered math performance is multifaceted and complex. The literature reports numerous interrelated factors associated with gendered math performance (Albano & Rodriguez, 2013; Betz, & Sekaquaptewa, 2012; Smeding, 2012; Tomasetto et al., 2011). In their literature review, Albano and Rodriguez (2013) explored gendered math performance outcomes from numerous extensive datasets. One such U.S.-based study investigated math performance in 10 states, sampling more than 7 million students. The data focused on a procedural method of instruction termed "opportunity to learn" or OTL.

Using OTL as a framework, Albano and Rodriguez (2013) investigated math performance in three countries: Germany, Singapore, and the United States. In both Germany and the United States, results indicated that gendered math performance scores were consistent with stereotypes (females performing more poorly than male counterparts). Among the beneficial aspects of the study was the intricacy of the study of exams or tests, drilling to the item level of the tests to explore question types that favored the genders. For example, Albano and Rodriguez (2013) found that at the item level the U.S.-based SAT was biased toward females; however, when taken as a whole, the SAT was biased toward males (Albano & Rodriguez, 2013; Mann & DiPrete, 2013).

Albano and Rodriguez (2013) confirmed what many authors have written: U.S. math scores are lower (*M* = 61.5, *SD* = 19.5) than scores in many other developed countries, third place in this study, behind Singapore (*M* = 70, *SD* = 16.5) and Germany (*M* = 66.5, *SD* = 0.19). Noteworthy because of its strong connection to the purpose of the current study were differences in gendered scores in both the United States (females *M* = 0.55, *SD* = 0.20; males *M* = 0.68, *SD* = 0.19) and Germany (females *M* = 0.63, *SD* = 0.19; males *M* = 0.70, *SD* = 0.19), but missing in Singapore's math achievement data (females *M* = 0.70, *SD* = 0.16; males *M* = 0.70, *SD* = 0.17). The authors did not explore an explanation for this lack of gendered math achievement nor for the placement of Singapore as having the highest mean math achievement among the countries surveyed. The research by Albano and Rodriguez (2013) confirmed that math achievement scores are gendered in both the United States and Germany.

Tomasetto et al. (2011) sampled 124 primary grade (elementary) students, their parents, and their teachers in a predominantly White middle-class neighborhood in the United States. The purpose of the study was to investigate gendered math performance based on parental views of gendered math stereotypes. On a scale of 1 to 5 (1 = least stereotype, 5 = greatest stereotype), parents' gendered stereotype was not significantly different. Mothers (*M* = 2.22, *SD* = 0.80) and fathers (*M* = 2.45, *SD* = 0.09) had similar scores. The results showed no significant relationship between parents' gendered stereotype and girls' math performance. However, a significant result from the study indicated the effects of stereotype threat on the girls' math performance but no mean effect from parents' gendered stereotype. The following quote explains the girls' math performance in light of the mothers' stereotype threat.

> ST led to the [daughter's] classic performance deficit when mothers' stereotypes were relatively stronger, whereas ST had no effect when mothers' level of stereotypes was lower. In other words, math performance of girls whose mothers endorsed gender stereotypes suffered from performance decrement under ST, whereas performance of girls whose mothers strongly rejected gender stereotypes did not demonstrate the negative consequences of ST. (Tomasetto et al., 2011, p. 946)

Figure 5 illustrates this relationship.

The mean scores for girls represented in Figure 3 were based almost exclusively on the introduction of a stereotype threat and not on parents' gendered stereotype. On a scale of 1 to 5, both parents' mean gendered stereotype scores were approximately 2.5 (see mean scores and standard deviations in the paragraph above). What is significant about the graph is that, at this young age (Grades K–3), society has already been effective in introducing a gendered message to girls that their math performance must be lowered simply because they are girls. This is especially

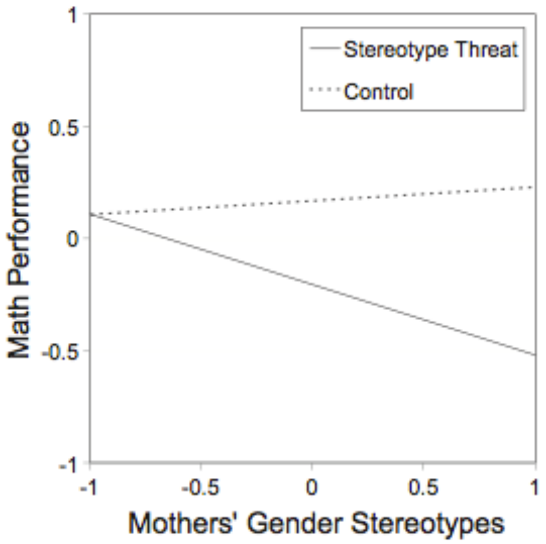


FIGURE 5. Standardized math performance as a function of standardized mothers' gender stereotypes and stereotype threat. Source: "Girls' Math Performance Under Stereotype Threat: The Moderating Role of Mothers' Gender Stereotypes," by C. Tomasetto, F. Alparone, & M. Cadinu, 2011, *Developmental Psychology, 47*, p. 947.

troubling due to the recency of the study (2011), the myriad efforts to reduce gendered math stereotypes, and the sample population (White, middle-class students). When considering these factors, one would expect the outcome to be less pronounced.

A Gender-Fair Education

Zohar (2006) popularized the term *gender fair* (p. 1580) to describe the conscious effort to make learning equally appealing to both genders (Greenberg, 2006; Zohar, 2006; Zohar & Bronshtein, 2005; Zohar & Gershikov, 2007). Genderfairness is often context based; how the lesson is framed provides the catalyst for the student to understand the topic. For example, the following three quotes provide context-specific bias for three groups: boys, girls, and gender neutral. In each, the ability of the group (or both groups in the case of neutral) to understand the topic is increased because the group can frame it more effectively.

> (Stereotypically) boys' contexts: Contexts reflecting topics that are stereotypically thought of as interesting and attractive for boys, such as cars and airplanes.
>
> (Stereotypically) girls' contexts: Contexts reflecting topics that are stereotypically thought of as interesting and attractive for girls, such as dolls, clothes, and jewelry.
>
> Neutral contexts: Contexts reflecting topics that are thought of as equally interesting and attractive for boys and girls such as animals, plants, and fruit. (Zohar & Gershikov, 2007, p. 682)

The educator who understands and practices a gender-fair education will see lessons understood more equitably (Greenberg, 2006; Zohar, 2006; Zohar & Bronshtein, 2005; Zohar & Gershikov, 2007). To illustrate the effect of stereotype examples affecting the learner's outcomes, Zohar and Gershikov (2007) conducted a lesson using multiple context-specific examples. The results of the lesson were described as follows.

> The context of one task was stereotypically male, and the context of the second task was neutral. While boys were not affected by the context of the task, girls performance was considerably affected by the version of the software. They performed significantly higher on the task with the neutral context as compared to the task with the stereotypically male context. (p. 680)

STEM Education

STEM education is unique among the disciplines, for two reasons. First, fewer people are entering STEM fields, while the need for STEM personnel continues to grow (Boe, Henriksen, Lyons, & Schreiner, 2011; Britner, 2008; Finson et al., 2006). Second, STEM is predisposed to more didactic pedagogies that have been demonstrated to transfer information less effectively than other, more inquiry-based pedagogies (Akcay & Yager, 2010; Britner, 2008; Finson et al., 2006; Stipek et al., 2001).

The Nature of STEM

Stipek et al. (2001) focused their research on the nature of math and, by extension, other STEM disciplines. For example, they asked whether math is a "procedure to solve problems or a tool for thought" (p. 213). Also, concerning the nature of math, they asked whether learning is for "focusing on getting correct solutions [or used to] understand mathematical concepts" (p. 213). These are key questions because at their base lies the all-important question: How should math or STEM disciplines be taught? Is there a "better" pedagogy when teaching STEM disciplines, or is pedagogy just a matter of preference?

STEM disciplines require the learner to link theory to practice, to take an abstract idea, and to practice it in a lab session. The ability of the student to practice the skill in the lab is integral to STEM education because, without practical application, much of what STEM teaches will not transfer in ways that will allow the student to apply it successfully (Akcay & Yager, 2010; Sabah & Hammouri, 2010; Zohar & Sela, 2002). The need for STEM professionals to apply their skills to practice can be underscored by these examples. If a medical care professional cannot understand the application of his or her practice, the consequence could be life threatening. Not to diminish the importance of other disciplines but to contrast them, if a librarian fails to apply his or her practice, the likelihood of a catastrophic outcome is low. In addition, the health care professional whose understanding is less than that of peers will be more likely to provide poorer care for patients. To learn as much as possible and to learn it in as thorough a way as possible and with the greatest practical applicability as possible are the desired outcomes of STEM education (Akcay & Yager, 2010; Sabah & Hammouri, 2010; Zohar & Sela, 2002).

The typical STEM college class has been portrayed as a place where knowledge may be transferred ineffectively due to pedagogies.

> Schoneweg . . . concluded that a typical college science course does not help students develop more appropriate understanding of the nature of science, nor new technologies and their value to people, nor the importance of involvements and interactions within society as a whole. He further noted that there is little or no discussion about the nature of science, technology, and everyday applications of science concepts and principles in most preparatory programs. Interestingly, everyday applications consist mainly of professors listing examples during a lecture if at all. Both the National Science Education Standards . . . and Science for All Americans . . . indicate that the teaching and learning of science must go far beyond the simple transmittal of scientific facts, figures, and processes. Science instruction enables students not only to understand the nature of scientific and technological enterprises but also to analyze scientific information critically as well as apply it to deal with real world issues. (Akcay & Yager, 2010, p. 644)

STEM Educators

With the exception of primary school teachers, the literature concerning STEM educators is surprisingly homogenous. In general, STEM educators are male, primarily use didactic pedagogies (Akcay & Yager, 2010; Britner, 2008; Finson et al., 2006; Stipek et al., 2001), have teacher-centered classrooms (Akcay & Yager, 2010; Stipek et al., 2001), and have less interaction and patience with female students than with male students (Zohar & Bronshtein, 2005; Zuga, 1999).

Pedagogical Methods

"It is not unreasonable to conclude that—among other factors—the teacher's teaching style has some impact on student learning and the perceptions students develop about science learning and the work of scientists" (Finson et al., 2006, p. 8). Finson et al. (2006) were alluding to "teaching style" as a "factor" in "student learning" (p. 8); however, as this portion of the literature review demonstrates, pedagogy is at the center of student learning. The literature declares teaching style as a high-stakes component in the education equation and confers a profound importance on the pedagogy used, its effect on student learning, as well as gender disparities that arise when constructivist or didactic methods are employed. In the following subsections, two dichotomous pedagogical methods are scrutinized for their multifaceted effect on education, educating, knowledge retention, putting knowledge to practice, gender inequities, and learning in general: *connected knowledge* and *separate knowledge.* The pedagogies are contrasted to demonstrate the differences between them and the effects of these differences.

Connected Knowledge

Popularized by Belenky et al. (1986) in the mid-1980s, connected knowledge shares characteristics with other forms of pedagogies, including constructivism, inquiry-based learning, exploration, critical thought, reasoning, and so on. While these share similarities, connected knowledge is unique in that it seeks to understand the topic from a *gendered* perspective. In *Women's Ways of Knowing* (Belenky et al., 1986, 1997), the authors related personal stories to describe the characteristics that define the ways in which women process thought.

Among the pedagogies that are akin to connected knowledge is constructivism, the origin of which is primarily attributed to John Dewey. Constructivism promotes the learner to "construct" meaning in the educational setting (Akcay & Yager, 2010; Finson et al., 2006; Levitt, 2002; Mulhall & Gunstone, 2012; Pruitt, 2012). This is not to suggest that the teacher is silent or absent; rather, the teacher promotes an environment in which discovery items are available for the student to construct meaning from the exercise. Levitt (2002) summarized activities that define constructivism: the "exploration of questions, critical thought, understanding in context, argument, and doing science" (p. 2). Finson et al. (2006) argued that teachers who use constructivist pedagogies are more closely aligned with what actually occurs in science settings.

Separate Knowledge

Separate knowledge, a term also popularized by Belenky et al. (1986, 1997), is the antithesis of connected knowledge. While the two learning methods coexist within the learning domain and both genders use both methods to acquire knowledge, the methods are distinctly different in their effect in the learning domain (Galotti et al., 1999). Marrs and Benton (2009) described *separate knowing* as "a highly analytical approach to knowledge construction" (p. 60). Like connected knowledge, separate knowledge seeks to understand the topic from a gendered perspective (Belenky et al., 1986). Marrs and Benton (2009) described the "separate knower" as "more likely to approach opportunities to construct knowledge from a critical, objective perspective. Put another way, separate knowers begin by objectively analyzing a situation, and then trying to understand another person's perspective" (p. 58).

Since the focus of this study is the pedagogical method that best serves STEM classes that lead to the hard sciences, the following quote seems apropos.

> Galotti et al. (1999) found that separate knowers and connected knowers tended to endorse different characteristics of the "ideal" college teacher. Connected knowers tended to prefer instructors who are "in control," "accepting," "helpful," "facilitating," and "emotional." In contrast, separate knowers tended to prefer teachers who are "authoritative," "demanding," "enthusiastic," and "critical." (Marrs & Benton, 2009, p. 65)

The intersection of the research by Belenky et al. (1986) and Galotti et al. (1999) suggests that the genders not only learn differently, but also instinctively understand which pedagogy best serves their learning style.

Conclusion

The literature review demonstrates a relationship between pedagogy and female success in STEM majors. The U.S. Census Bureau (2013) estimated that 50.8% of Americans were female in 2012. The fact that many STEM majors are predominantly male in enrollment and persistence through graduation means that the national education system is losing a large percentage of candidates to these STEM professions. With too few American STEM professionals available, companies have turned to foreign-born STEM professionals. The use of STEM foreigners presents potential risks for national and intellectual property securities. The Department of Defense has considered this concern a national emergency (U.S. Citizenship and Immigration Services, 2014).

The Problem

The problem explored in this study is the demand for STEM professionals compared to the number of STEM graduates. Females comprise approximately 50% of the American population, 48% of the American work force, but only 24% of STEM personnel. In certain STEM professions, that disparity is even greater. Certain STEM majors are predominantly male in enrollment and persistence through graduation, meaning that the national education system is losing a large percentage of candidates for these professions. If students in STEM majors were roughly equal in gender, the number would almost double, and thus the nation's deficit in STEM professional would likely diminish or even disappear. This literature review explored the reasons for separate knowledge pedagogy's predominant use in STEM education.

Why This Is a Problem

The problem of insufficient STEM professionals coming from the U.S. educational system can be considered a national emergency. When organizations that produce sensitive information (e.g., defense or intelligence) cannot find sufficient numbers of STEM professionals to meet their needs, they are forced to hire foreign-born STEM professionals. This presents a high-risk situation for the information and technology that these professionals produce.

The Salient Points of the Literature

First, the problem is longstanding, persistent, and multifaceted. Second, the longer the problem remains, the greater the deficit of STEM professionals. Third, the lack of sufficient STEM professionals challenges technological innovations that depend on STEM professionals (e.g., advances that lead to increased quality of life; meeting the global demand for sufficient food, clean water, effective health care, environmentally responsible energy production).

Chapter Summary

This literature review is gleaned from a diverse group of authors, from a diverse group of disciplines, and from diverse social and cultural contexts; it spans several decades and at least four continents. While connected knowledge frames the problem from a feminist perspective, it shares enough similarities with constructivist and inquiry-based pedagogies that these can be used to address questions about the success of females in STEM disciplines.

CHAPTER 3

METHODOLOGY

This study seeks to increase what is known about female math students' academic achievement (as reflected by self-reported grades) and how that relates to their preference for a Connected Knowledge pedagogy. The research question that framed this process is, *Do STEM students prefer to learn with one pedagogical method more than another?*

General Methodological Design

This quantitative study utilized a comparative correlational research design. According to Jacobs (2014), the purpose of comparative correlational research "is to determine the extent to which two (or more) variables are related" (Slide 39). There are three possible correlational relationships among variables: "a finding of no relationship, a positive correlation, or a negative correlation" (Tuckman & Harper, 2012, p. 189). Another key element of this design is that the "independent variable has already occurred or cannot be manipulated" (Jacobs, 2014). Often referred to as "ex post facto" or "after the fact" research, comparative correlational research examines variables that cannot be manipulated (Tuckman & Harper, 2012). For example, in this study the independent variables of gender and pedagogy cannot be manipulated. Therefore, comparative correlational research is nonexperimental in nature; there is no control group, nor is there a treatment. The dependent variable in this design is the variable of interest, and the dependent variables are what the literature states are the most probable to cause the effect (Jacobs, 2014).

In the comparative correlational design, the literature review is of great importance because the relationship of the variables could be caused by an unanticipated effect, called “extraneous variables.” Therefore, using the literature, the researcher must make concerted efforts to include those extraneous variables so they can be measured and thereby determine whether they had an effect on the outcome (Jacobs, 2014). A limitation of the comparative correlational research design is its nonexperimental nature; the groups are not randomly assigned. The lack of a pretest, treatment, and posttest found in experimental designs is also a limitation (Tuckman & Harper, 2012). Figure 6 illustrates the relationships among the research questions, variables, survey questions, and the reviewed literature.

Population

The target population for this study was postsecondary students enrolled in prerequisite math classes that lead to a bachelor’s degree in engineering, chemistry, or physics. At the university where this study was done, there were four math classes that met this criterion: Precalculus Trigonometry, Precalculus Algebra, Calculus I, and Calculus II. Students who either “test into” or complete this math sequence meet the entry requirement for engineering, chemistry, and physics majors. Therefore, to ensure a highly representative sample, only those classes that fulfilled these requirements were surveyed for this study.

The research site for this study was a 4-year public university in southern California. In 2012, the undergraduate student population was approximately 72% of the institution’s total population. Of those undergraduates, the ethnic diversity was approximately 3.5% African American, 19.5% Asian American, 21.0% Caucasian, 28.0% Latino/a, and 0.6% Native American. Undergraduate females comprised approximately 35% of the institution’s population, while undergraduate males comprised approximately 48%. Students seeking bachelor’s degrees in the School of Mathematics were approximately 9% of bachelor degree seekers in the institution (citation withheld to maintain anonymity).

Sample

The demographics of the sample were gained from responses to the first five questions on the survey, regarding gender, age range, ethnicity, disability, and declared major.

The sample included 224 males (46.1%), 260 females (53.5%) and 2 (0.4%) respondents who did not identify their gender (Table 3).

TABLE 3. Gender Distribution of the Sample

Gender	*f*	%
Male	224	46.1
Female	260	53.5
Missing	2	0.4

Since the survey was conducted at a 4-year public university, it was expected that the sample age range would be clustered in the young adult age range, and this was the case. The sample consisted of 433 (89.1%) students ages 18 to 20 years and

31 (6.4%) students ages 17 or less. The only other age range with greater than 1% was ages 21 to 23 years (*n* = 15, 3.1%). Table 4 summarizes the data on age distribution.

TABLE 4. Age Distribution of the Sample

Age Range (Years)	*f*	%
17 or younger	31	6.4
18 to 20	433	89.1
21 to 23	15	3.1
24 to 26	4	0.8
27 or older	2	0.4
Missing	1	0.2

The sample's ethnic diversity was broadly representative of the university's ethnic diversity. Table 5 reports the sample's ethnic diversity. Since 22 (4.5%) of the respondents selected "other," the researcher elected to investigate this further. Of the 22 respondents who answered "other," 5 (1.0%) answered "Middle-Eastern" and 13 (2.7%) self-identified with multiple ethnicities. The remaining 4 (0.8%) in the "other" category identified as Indian, Armenian, "Hanian," or Greek.

Question 4 asked whether the student had a disability that "affects your ability to do math well"; 461 (94.9%) respondents answered *no*, 23 (4.7%) answered *yes*, and 1 (0.2%) answered *maybe*. Students who answered *yes* were asked to identify the disability; the most common disabilities were Dyslexia (*n* = 8), ADHD (*n* = 6), ADD (*n* = 2), bad vision (*n* = 2), and depression/anxiety (*n* = 2); the remaining disabilities

TABLE 5. Ethnic Distribution of the Sample

Ethnicity	*f*	%
African American	23	4.7
Asian	154	31.7
Caucasian/White	89	18.3
Hispanic/Latin	187	38.5
Native/Alaskan	2	0.4
Native/Pacific	8	1.6
Other	22	4.5
Missing	1	0.2

were all single counts. Of those who identified as having a disability, 10 were male and 14 were female. Table 6 summarizes the data on student disability in math.

TABLE 6. Students' Self-Report of Disabilities Affecting Math Capabilities

Reported Disability	*f*	%
No	461	94.9
Yes	23	4.7
Maybe	1	0.2
Missing	1	0.2

The final demographic question asked the respondent to identify her/his college major. The targeted population for this study was STEM majors; therefore, the researcher selected those math classes that were prerequisites to STEM fields at the institution where this study took place. The majority of the respondents were STEM students. The most frequently selected major was science (25.9%), following by engineering (21.0%), kinesiology (13.8%), and other (11.5%). When totaled, 366 respondents (75.3) reported STEM majors. Table 7 summarizes the data on majors.

Instrument

The Attitudes Toward Think and Learning Survey (ATTLS) used in this study was developed by Galotti et al. (1999) to assess learning preferences of STEM students. Specifically, ATTLS was designed to test for Connected Knowledge versus Separate Knowledge learning preferences. It is intended to answer the question, “Do STEM students prefer to learn with one pedagogical method more than another?”

The primary author of the ATTLS, Dr. Kathleen M. Galotti, William H. Laird Professor of Cognitive Science and Director of Cognitive Science at Carleton College in Northfield, Minnesota, agreed to provide access to the ATTLS at no charge, asking only that she receive a report the results of the study following completion. She also provided the “Instrument Keys.”

In fall 2013, the researcher administered the ATTLS in a pilot study at a nearby community college. The results of the pilot study were instrumental in supplementing the ATTLS to address the research questions in this study. In Dr. Galotti’s research, she had access to student scores and grades, which were not available for the pilot study; therefore, the dependent variable, student achievement, was missing. A thorough review of the literature revealed variables that were not

TABLE 7. Majors Reported by Respondents

Major	*f*	%
Other	22	4.5
Business	9	1.9
Chemistry	16	3.3
Computers	33	6.8
Education	5	1.0
Engineering	102	21.0
Liberal Studies	10	2.1
Nursing	6	1.2
Physics	3	0.6
Science	126	25.9
Kinesiology	66	13.6
Undeclared	39	8.0
Biology	13	2.7
Psychology	6	1.2
Nutrition/Dietetics	10	2.1
Multiple majors	8	1.6
Math/Math Education	4	0.8
Athletic Training	4	0.8
Biochemistry	3	0.6
Missing	1	0.2

included in the instrument but were purported to influence the success of female math students; therefore, these were included in the iteration of the instrument for this study.

Because this study was designed to understand differences between male and female math students, both genders were surveyed and asked the same questions. Additional survey questions asked for demographic information such as age, ethnicity, and learning disability; these factors were analyzed to determine whether there was a correlation between these and female self-reported grade. Two qualitative questions were added to the survey to garner student opinion. These questions, numbers 41 and 42, became a part of the instrument (Appendix A).

The resulting instrument was a hybrid of the ATTLS (Galotti et al., 1999) and the researcher's modifications: Questions 6–25 of the survey instrument, from the original ATTLS, assess a student's preference for Connected Knowledge versus Separate Knowledge learning (or, by extension, pedagogy). These questions, along with Question 33 (math grade self-reporting), were designed to answer the question, *Does pedagogy (Connected Knowledge versus Separate Knowledge) predict student achievement?*

The question, *Does gender predict student achievement?* was addressed by survey Question 1 (gender) and Question 33 (math grade self-reporting). Questions 2 (age range), 3 (ethnicity), and 4 (disability that affects math ability) were added based on the literature review that suggests that math performance can be affected by these variables. Question 37 was intended to determine whether student math performance is better, worse, or the same, when compared to the student's other subjects. Questions 38 and 39 were designed to understand whether there was a particular area of math in which the student did better than in others (e.g., homework, quizzes, exams, and so on). Questions 40 and 41 are qualitative questions to provide the student an opportunity to explain his/her reasons for being successful or unsuccessful in math.

Data Preparation

Prior to analyzing the data, several composite variables were created and several variables were recoded. The following list explains the composite and recoded variables.

1. Using the key provided by Dr. Galotti, author of the ATTLS, a composite scale variable labeled CK (Connected Knowledge) was created from the 10 items that Dr. Galotti identified as CK: 6, 9, 10, 13, 15, 19, 20, 22, 24, 25.

2. Using the same key, a composite scale variable labeled SK (Separate Knowledge) was created from 10 items: 7, 8, 11, 12, 14, 16, 17, 18, 21, 23.

3. Question 33, student self-reported grade, an ordinal variable, was recoded into a categorical variable (pass/fail). Students who answered Question 33 with 70% or greater, or C or greater, were recoded as Pass and students who answered with 69% or lower, or D or lower, were recoded as Fail. Of the 482 respondents, only 3 males and 11 females answered Question 33 by reporting a “failing” grade. Discussed in Chapter 5, this skewed response created problems in the analysis and became a limitation of the study. To eliminate this condition in a future study, the researcher would request grade data for students from the classroom teacher; also the survey would request that students include the last several digits of their student ID, allowing a link of the student’s actual grade to the survey without identifying the student.

4. A categorical (nominal) variable Class Type was created. Prior to entering the data into the statistical analysis software, a number was written on each survey to identify the class in which the survey was administered. All surveys were kept separate by class; the number written on the survey included first the class, then the number of the survey. For example, Class 1 Survey 1 was labeled 1.1, Class 1 Survey 2 was labeled 1.2, and so on. The Class Type variable allowed the researcher to identify the class and teacher for each survey. Since this list would compromise the identity of the classroom teacher and since a condition of participation was for the teacher to remain anonymous, the recoded variable was not detailed.

5. A categorical (nominal) variable Class Name was created. Six classes were surveyed; four of the six classes were Pre-Calculus Algebra, one was Calculus II, and one was Survey of Calculus I. All six classes met the criteria for participation in the study; that is, the class was a "gateway class to the hard sciences." The four Pre-Calculus classes were coded "1," the Calculus II class was coded "2, and the Survey of Calculus I class was coded "3."

6. The categorical (nominal) variable Gender was recoded in keeping with best practices. Prior to recoding, Gender was coded 1 = male, 2 = female; after recoding, the new variable Gender_Dichotomy was coded 0 = male, 1 = female.

7. Because some of the students provided percentage scores for Question 33 (the student self-reported grade variable), the researcher created a new scale-level variable labeled "thisgrade33.1" for these respondents. Of the 486 completed surveys, only 153 (31.5%) provided these data, thus limiting analysis using this new variable.

8. Three new ordinal variables were created for Question 33 (student self-reported grade): A_Grade, B_Grade, and C_Grade. These new variables were created to further analyze Student Achievement, a variable of interest.

Data Collection

Participants were surveyed once. The researcher utilized paper (hard copy) surveys for the study. The hard copy survey method has differences from the web-based survey method. Among these difference are response rates and data entry error (Cook, Heath, & Thompson, 2000). According to Cook et al. (2000), the response rate for hand-delivered, hard copy surveys far exceeds that of web-based surveys. According to Creswell (2009), surveying a representative sample allows a researcher to make generalizations about the population.

A dissertation committee member whose title includes Coordinator of the Graduate Program for Mathematics Education provided assistance in gaining access to professors who teach the engineering, chemistry, and physics math gateway classes of Precalculus Trigonometry, Precalculus Algebra, Calculus I, and Calculus II. The committee member contacted peer math faculty in the School of Mathematics via email (Appendix B) and math professors who taught the targeted classes in the fall 2014 semester responded. The professors were given details of the study and gave consent to participate.

In the fall 2014 semester, after the study was approved by the Institutional Review Board (IRB; Approval # 653962-2), each math faculty member who had agreed to participate in the study received an envelope with a letter of thanks, a script (Appendix C) to read prior to administering the survey, and enough packets for the number of students enrolled in the course. Each packet consisted of, in this order, two informed consent forms (Appendix D; one for the participant to keep and the other to sign and return with the completed survey instruments), and 1 survey instrument (Appendix A). These three items were paper clipped, not stapled together.

Each math faculty member read the script, then distributed the packets to all students. Each student who agreed to participate signed the informed consent form, keeping one copy and returning the other copy with the completed survey. Each student placed the informed consent form in the box labeled "Consent Form" and the completed survey in a separate box labeled "Survey." Both boxes were located at a "neutral" location in the classroom. Both boxes were sealed by the last student to place a form or survey in the box.

Protection of Participants

It is the responsibility of every researcher to minimize risks for all participants in all studies. IRBs require any member of the academic community, whether faculty, staff, administrator, or student, to submit an application prior to contact with "human subjects." Part 15 of the IRB application for this study, titled "Potential Risks," required the researcher to "describe the potential risks this research present to the dignity, reputation, rights, health, welfare, or psychological well-being/comfort of the subjects." Part 16, titled "Protecting Against or Minimizing Risks," required the researcher to "describe the measures you will take to protect against or to minimize each." The IRB application was submitted for review, and the IRB approved it, deeming it to address the risks and protection sufficiently.

The risks identified for this research study were as follows: (a) The participant might experience some level of psychological distress from a question; or (b) the participant might think that his or her classroom grade or performance might be affected by participation, or lack thereof, in the study. To reduce or eliminate these potential risks, steps were taken to maintain anonymity, but the anonymity could not be completely guaranteed. To minimize these risks, the following actions were put in place: (a) Participants had the option to skip questions; (b) the script that the classroom professor read before distributing the packet and the consent form provided clear information about the ability to opt out of the study without fear of reprisal; and (c) to ensure as much anonymity as possible, the participants were not asked to provide any identifying information. The survey was designed so that all collected data would be anonymous. Participants also had the right to discontinue the survey at any time or to skip any question.

An example of these protections can be seen in the following statements, found in the script that the math professor read prior to distributing the packets: "You do not have to participate, and to opt out, you can simply leave both the informed consent form and survey blank," "If you do not want to participate in the study, then simply do not sign the informed consent form and do not complete the survey," "Again, you are not obligated to participate in the study; you can turn in a blank informed consent and survey should you choose not to participate," and "Once you have completed the survey, or have chosen to leave it blank, please place it in the box labeled 'survey." The previous four statements were included in the script that the math professor read prior to distributing the packets and in the Informed Consent Form that the student signed before completing the survey:

> PARTICIPATION AND WITHDRAWAL
>
> You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequence of any kind. Participation or nonparticipation will not affect your treatment, care, grade or any other personal consideration or right you usually expect. You may also refuse to answer any questions you do not want to answer and still remain in the study.

Reliability and Validity

Miller (2012) discussed an evolving concern with higher education survey methodology: the emerging area of report bias based on "social desirability." The notion of meaningfulness based on one's social networks was studied in the National Survey of Student Engagement (NSSE). Researchers studied how self-report surveys (such as the one used in this study) might be affected by students' current social media climate (e.g., Facebook, Instagram, Twitter); specifically, would reporter bias emerge as an effect to these in academic studies? Results reported by Miller (2012) demonstrate nonsignificant interaction between student self-reporting and social desirability; therefore, the strength of this study's use of self-reported student surveys was assumed to fall within previous norms. Self-report student surveys were deemed not to diminish the quality of the reported information.

In 1999, Galotti et al. provided the following psychometric evaluation of their instrument's reliability and validity:

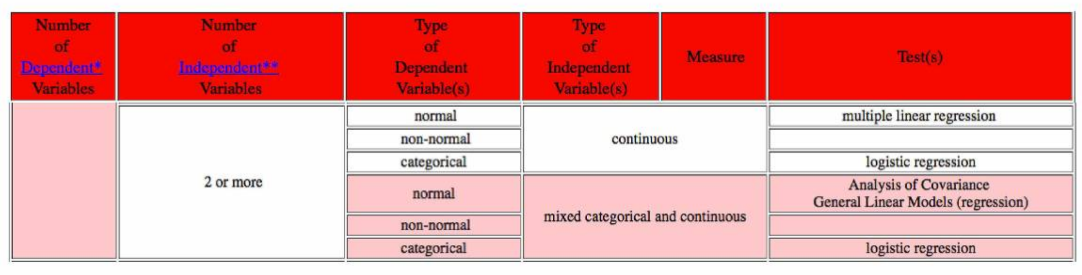
> Internal reliabilities (computed with coefficient alpha) were calculated separately for Sample 1, who used a slightly different instrument from the other samples, who all used the same instrument and whose data were thus combined in one analysis. For Sample 1 (*N* = 128), the internal reliability was .83 for the SK scale and .76 for the CK. For the combined analysis of the data

> for Samples 2–4 (*N* = 248), the internal reliability for the SK scale was .83, and .81 for the CK scale. These results establish acceptable levels of internal reliability for the instrument. Correlations were also calculated between SK and CK scores, again separately for participants of Study 1 (*r* = -.07), and then for the combined data from participants of Studies 2–4 (*r* = .01). Neither correlation approached statistical significance. These results suggest that the two "ways of knowing'' are in fact independent, as opposed to mutually exclusive. (pp. 750–751)

Data Analysis

This study used one ordinal dependent variable (student self-reported grade) and two independent variables (gender [categorical] and pedagogical preference [ordinal]). Since most every undergraduate academic class and institution in the United States determines student success as a "C" grade or better, the dependent variable was converted into a dichotomous variable (Pass/Fail); those students who self-reported a grade of "C" or higher, or 70% or higher were categorized as Pass; those who self-reported a grade of "D" or lower, or 69% or lower, were categorized as Fail.

In keeping with best practices, the data were analyzed from simple to complex, based on the output from the previous test. If the lower statistical test found statistically significant results, higher-level, more rigorous tests were performed. For example, once descriptive statistics were run and analyzed, Spearman Rank Order (Rho) correlations were performed to explore relationships. Because the Rho output indicated many significant relationships between the dependent and independent variables, Chi-square tests for independence were performed. Again, in keeping with best practices, since the Chi-square test produced at least one result that approached statistical significance, several independent samples *t* tests were performed to further explore the research questions. And finally, because the *t* tests provided statistically significant findings, a logistic regression analysis was performed. According to Leeper (n.d.), the highest level of statistical tests for this study is logistic regression (Figure 6).



Number of Dependent* Variables	Number of Independent** Variables	Type of Dependent Variable(s)	Type of Independent Variable(s)	Measure	Test(s)
	2 or more	normal	continuous		multiple linear regression
		non-normal			
		categorical			logistic regression
		normal	mixed categorical and continuous		Analysis of Covariance General Linear Models (regression)
		non-normal			
		categorical			logistic regression

FIGURE 6. Choosing the correct statistical test. Source: *Choosing the Correct Statistical Test in SAS, Stata and SPSS,* by J. Leeper, n.d., retrieved from http://bama.ua.edu/~jleeper/627/choosestat.html

Chapter Summary

The literature suggests a relationship between pedagogy and female student success, especially in certain STEM majors. To test this relationship, a survey was constructed that consisted of the established ATTLS (Galotti et al., 1999) supplemented by a researcher-developed instrument. The researcher obtained IRB approval prior to the study. The survey was administered to a representative sample of students in the math department at a 4-year public university in southern California. The Statistical Package for the Social Sciences (SPSS) Version 22 was used to analyze the data. The results of the analysis are reported in Chapter 4, and conclusions and recommendations are presented in Chapter 5.

CHAPTER 4

FINDINGS

The purpose of this study was to determine whether there was a significant relationship between gender and pedagogy in prerequisite math classes that lead to the hard sciences (e.g., chemistry, physics, and engineering). Since the literature clearly demonstrates that participation and persistence by females in the hard sciences is significantly lower than by males, this study explored whether pedagogical preferences could help to explain that gap.

The research question that guided this study was, *Do STEM students prefer to learn with one pedagogical method more than another?*

Data Analysis

Descriptive Statistics

A brief summary of the sample is provided here; a complete description is found in Chapter 3. The sample include 224 males (46.1%), 260 females (53.5%), and 2 (0.4%) respondents who did not identify gender. The sample consisted of 433 (89.1%) 18- to 20-year-olds and 31 (6.4%) who were 17 years old or younger. The only other age range with greater than 1% was 21- to 23-year-olds (*n* = 15, 3.1%). The sample's ethnic diversity was broadly representative of that of the university; details are provided in Chapter 3.

Question 4 of the survey asked whether the student had a disability that "affects your ability to do math well"; 461 one (94.9%) respondents answered *no*, 23

(4.7%) answered *yes*, and 1 (0.2%) answered *maybe*. Students who answered *yes* were asked to identify the disability; the most common disabilities identified were dyslexia (n = 8), ADHD (n = 6), ADD (n = 2), bad vision (n = 2), and depression/anxiety (n = 2); the remaining disabilities were all single counts. Of those who identified as having a disability, 10 were male and 14 were female.

The final demographic question asked the respondent to report college major. The targeted population for this study was STEM majors, and the majority of the respondents were STEM students. In descending order, the most frequently selected majors were science (25.9%), engineering (21.0%), kinesiology (13.8%), and other (11.5%). There were 366 STEM majors (75.3% of the sample).

Spearman Rank Order Correlation

After creation of the composite variables and recoding for best practices, the data were analyzed for correlations to explore relationships among the variables. A detailed description of the composite variables and recoding was presented in Chapter 3. The Spearman rank order correlation (r) was used based on the variable types (ordinal). In keeping with best practices, significance was based on established levels: r = .10 to .29 was gauged "small," r = .30 to .49 was gauged "medium," and r = .50 to 1.0 was gauged "large" (Pallant, 2013). Although many significant relationships were identified at the two-tailed .01 level, this was expected due to the large sample size (N = 486); therefore, only those significant relationships that were meaningful based on the research questions are identified herein. The entire correlational matrix is reported in Appendix E).

The following relationships, directly related to the research question, were investigated. Table 8 summarizes the results.

TABLE 8. Results of Spearman Rank Order Correlation Tests of Association

Variable	Gender (female)	Connected Knowledge	Separate Knowledge	Student Achievement
Gender (female)	1.000	.170**	-.216**	-.086
Connected Knowledge	.170	1.000	.260**	.052
Separate Knowledge	-.216**	.260**	1.000	-.019
Student Achievement	-.086	.052	-.019	1.000

**Significant at the .01 level (2-tailed).

1. The relationship between gender and the composite variable Connected Knowledge was investigated using the Spearman rank order correlation coefficient. There was a small positive correlation between the two variables, $r(478) = .170$, $p < .001$.

2. The relationship between gender and the composite variable Separate Knowledge was investigated using the Spearman rank order correlation coefficient. There was a small negative correlation between the two variables, $r(478) = -.216$, $p < .001$.

3. The relationship between gender and student self-reported grade was investigated using the Spearman rank order correlation coefficient. There was a

nonsignificant negative correlation between the two variables, *r*(480) = -.086, *p* = .059.

Chi-Square Tests for Independence

To explore further the results related to the research question, several additional tests were conducted. The first test analyzed the variables gender and student self-reported grade. The Chi-square test for independence indicated no significant association between gender and student self-reported grade, $X^2(1, n = 482)$, $p = .059$ (Table 9).

TABLE 9. Results of First Chi-Square Tests (*N* = 482)

Test	Value	*df*	Asymp. Sig.[a]	Exact Sig.[a]	Exact Sig.[b]
Pearson Chi-Square	3.578[c]	1	.059		
Continuity Correction[d]	2.623	1	.105		
Likelihood Ratio	3.845	1	.050		
Fisher's Exact Test				.099	.050
Linear-by-Linear Association	3.570	1	.059		

[a] Two-sided. [b] One-sided. [c] No cells have expected count less than 5; the minimum expected count was 6.48. [d] Computed only for a 2x2 table.

A second Chi-square test for independence was performed using the variable gender and self-reported grade (A through F) prior to recoding for Pass/Fail. The results showed no significant association between gender and self-reported grade, $X^2 (4, N = 482)$, $p = .348$ (Table 10).

TABLE 10. Results of Second Chi-Square Tests (N = 482)

Test	Value	*df*	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.452[a]	4	.348
Likelihood Ratio	4.862	4	.302
Linear-by-Linear Association	1.657	1	.198

[a] Four cells (40.0%) had expected count < 5; the minimum expected count was 3.24.

Independent Samples *t* Test

Independent-samples *t* tests were conducted to compare Connected Knowledge scores by gender. There was a statistically significant difference in scores for males (M = 52.65, SD = 7.69) and females (M = 55.14, SD = 7.50), $t(478) = -3.585$, $p < .001$. The same test was conducted for Separate Knowledge; there was a statistically significant difference in scores for males (M = 46.37, SD = 7.74) and females (M = 42.91, SD = 8.30, $t(478) = 4.70$, $p < .001$ (two-tailed; Table 11).

Logistic Regression

Following the independent-samples *t* tests, tests of logistic regression were performed. All assumptions associated with logistic regression (sample size, multicollinearity, and outliers) were tested to assure the results of the regression analysis would be valid.

Sample size. Descriptive statistics were run for the data set and reported in Chapter 3. Potential problems such as “solution failing to converge” (Pallant, 2013, p. 176) due to sample size were not present. The “solution failing to converge”

TABLE 11. Results of *t* Tests for Significance of Association Between Connected Knowledge and Separate Knowledge

Measure	Connected Knowledge	Separate Knowledge
Gender		
Male		
n	223	222
Mean	52.65	46.37
SD	7.69	7.74
Female		
n	257	258
Mean	55.14	42.91
SD	7.50	8.30
t Test for Equality of Means		
Equal variances assumed	-3.59	4.70
Equal variances not assumed	-3.58	4.73
Independent Samples Test		
Equal variances assumed		
Sig. (2-tailed)	.00	.00
Equal variances not assumed		
Sig. (2-tailed)	.00	.00
95% Confidence Interval		
Equal variances assumed		
Lower	-3.85	2.02
Upper	-1.13	4.91
Equal variances not assumed		
Lower	-3.86	-1.12
Upper	-1.13	4.90

problem is most common when sample sizes are small. When sample sizes are small, there may be a need to collapse variables to increase their count; however, because of this data set's large sample size when comparing the dependent variable Student Achievement with each independent variable, there was no need to collapse any of the variables ($N = 482$ for gender, $N = 476$ for pedagogy, and $N = 475$ for the interaction of gender and pedagogy). There were no violations of the assumption for sample size.

Multicollinearity. All variables used to address the research questions were investigated for violations of the assumption of multicollinearity. Collinearity statistics (Pallant, 2013) were gathered for the dependent variable student self-reported grade and compared to the independent variables Connected Knowledge, Separate Knowledge, Gender, and Class Type. A range of .857 to .951 for tolerance indicated no violation of the assumption of multicollinearity.

Outliers. In order to ensure that the regression model predicted only those cases associated with the correct category, the data set was tested for outliers using two tests: the Spearman rank order correlations (Rho) and cross tabulations (Crosstabs) for the variables of interests: Student Self-Reported Grade, Connected Knowledge, Separate Knowledge, Gender, and Class Type. The Rho test was first examined for significance associations by viewing the output and highlighting those significant associations. Once highlighted, significant associations were viewed by the researcher to determine whether their relationships made sense. Based on a detailed examination, there did not appear to be any significant outliers for the variables of interests. A more rigorous test was conducted to verify this result: the Chi-square test of independence. The result statistically verified no violation of the assumption for outliers.

Binary logistic regression. The final test in analyzing the data was binary logistic regression. All assumptions were tested prior to the analysis; none indicated a violation of the assumptions. Three logistic regressions were undertaken; all regressions used the ENTER method, which instructs the software to perform the analysis with no emphasis on any variable; all variables are treated equally, and no variable is weighted greater than another.

The first regression compared the dependent variable Student Self-Reported Grade to the independent variable of interest, Gender. The sample size for the model was 482 (99.2%), with 4 missing cases (0.8%). Results indicate no statistical significance, X^2 (1, N = 482) 3.85, p = .073. The model as a whole explained between .08 % (Cox and Snell R^2) and 3.4% (Nagelkerke R^2) of the variance in student self-reported grade and correctly classified 97.1% of the cases (adapted from Pallant, 2013, p. 186).

The second regression compared the dependent variable Student Self-Reported Greade to both composite pedagogy variables of interest: Connected Knowledge and Separate Knowledge; together, these formed the variable Pedagogy. The sample size for the model was 476 (97.9%), with 10 missing cases (2.1%). Results indicated no statistical significance, X^2 (2, N = 476) 3.57, p = .055. The model as a whole explained between .07 % (Cox and Snell R^2) and 3.2% (Nagelkerke R^2) of the variance in Student Self-Reported Grade and correctly classified 97.1% of the cases (adapted from Pallant, 2013, p. 186).

The third regression compared the dependent variable Student Self-Reported Grade to both independent variables of interest, Gender and Pedagogy. The sample size for the model was 475 (97.7%), with 11 missing cases (2.3%). When both predictor variables were examined together, results indicated a significant association between the independent variables (Gender and Pedagogy) and the dependent variable (Student Self-Reported Grade), X^2 (3, N = 475) 9.83, p = .016 for Connected

Knowledge and *p* = .023 for gender; the association between Gender and Separate Knowledge was not statistically significant, *p* = .162, indicating that the model distinguished between respondent gender and Connected Knowledge pedagogical learning preference. The model as a whole explained between 2.0 % (Cox and Snell R^2) and 8.8% (Nagelkerke R^2) of the variance in Student Self-Reported Grade and correctly classified 97.1% of the cases (adapted from Pallant, 2013, p. 186).

CHAPTER 5

SUMMARY OF THE STUDY

The world is becoming increasingly dependent on people who possess STEM-related skills and abilities. In 2007 the Bureau of Labor Statistics (BLS) estimated that, nationwide, STEM-related jobs would increase by 22% from 2004 to 2014 (BLS, 2007); however, there is a shortage of people in the United States to fill these positions. A possible contributor to the shortage of trained STEM professionals is that these fields have been male-dominated and females do not choose to enter these fields.

A gender gap exists in STEM disciplines (Else-Quest et al.; Shah, 2003; Upadhyay & DeFranco, 2008; Zohar, 2006). According to the U.S. Department of Labor, Women's Bureau (2012), the percentage of females who occupy the industrial engineering field is 18.8%. Nationally, there has been a significant rise in female industrial engineers' participation rate from 1985 until today (10.9% in 1985, 17.2% in 2000, and 18.8% in 2012); however, engineering still represents the lowest of all occupations that females occupy.

The gender gap is one of achievement, as reflected in persistence to degree completion of STEM majors (Curren, 2006; Else-Quest et al., 2010; Zohar, 2006). In some cases the gap begins as early as elementary school, is present in many middle school-age girls and boys, and solidifies in most high school-age young women and men (Akcay & Yager, 2010; Upadhyay & DeFranco, 2008). Some researchers have argued that this gap may be exacerbated by pedagogies that favor males and make learning more difficult for females (Blumberg, 2007; Finson et al., 2006; Zohar, 2006).

The purpose of this study was to investigate the pedagogical preferences of STEM students in math courses that are prerequisites to engineering, physics, and chemistry courses at a 4-year university in southern California.

The research question that guided this study was, *Do STEM students prefer to learn with one pedagogical method more than another?*

Because this study was designed to determine student perception between (a) the two predictor variables gender and pedagogy, and (b) the dependent variable student self-reported grade, a comparative correlational research design was utilized.

The instrument used in this study was a modified version of the ATTLS (Galotti et al., 1999). The original ATTLS instrument was pilot tested about 1 year prior to its use in this study. Deficiencies were noted and corrections were made to address the research question. The ATTLS was developed by Galotti and Clinchy (Galotti et al., 1999) to assess learning preferences of STEM students. Specifically, ATTLS was designed to test for Connected Knowledge versus Separate Knowledge learning preferences and to answer the question, “Do STEM students prefer to learn with one pedagogical method more than another?”

The target population for this study was postsecondary students enrolled in prerequisite math classes that could lead to a bachelor’s degree in engineering or physics. At the university where this study was conducted, four math classes met this criterion: Precalculus Trigonometry, Precalculus Algebra, Calculus I, and Calculus II.

Students who either “test into” or complete this sequence meet the entry requirement for an engineering or physics major. Therefore, to ensure the highest level of a representative sample, only those classes that fulfilled these requirements were surveyed for this study. Participants were surveyed once, using pencil and paper surveys.

The method used to recruit study participants was to contact the Coordinator of the Graduate Program for Mathematics Education, asking for assistance in gaining access to professors who teach the engineering and physics math gateway classes of Precalculus Trigonometry, Precalculus Algebra, Calculus I, and Calculus II. The Coordinator agreed to help and sent an email to math faculty in the School of Mathematics soliciting their participation. Shortly thereafter, the professors who taught the targeted classes in the fall 2014 semester responded. The researcher communicated the details of the study to each professor and secured that person’s willingness to participate.

In the fall 2014 semester, after IRB approval, each math faculty member who had agreed to participate in the study received an envelope with a letter of thanks, a script to be read prior to administering the survey, and enough packets for the number of students enrolled in the course. Each packet consisted of, in order, two informed consent forms (one for the participant to keep and the other for the participant to sign and return with the completed survey), and a copy of the survey. These three items were paper clipped, not stapled. All of these items appear in the appendices.

The math faculty member read the script and then distributed the packets to the students. Each student who agreed to participate signed the informed consent form, returning one copy with the completed survey. Completed consent forms and surveys were appropriately placed in the boxes labeled “Consent Form” and “Survey” and located at a “neutral” location in the classroom. Both boxes were sealed by the last student to insert a form or survey.

Findings

Gender-Related Findings

The sample had gender diversity representative of that of the institution: 53.7% (n = 259) females and 46.2% (n = 223) males. The data did not indicate a statistically significant relationship between gender and student’s perception of their success; 45.6% (n = 220) of the females self-reported passing grades, while 51.4% (n = 248) of the males self-reported passing grades. The Spearman rank order correlation coefficient between gender and self-reported grades did not reach statistical significance; there was a negative correlation between the two variables, $r_s(480) = -.086$, $p = .059$. The Chi-square test for independence indicated no significant association between gender and student self-reported grade, X^2 (1, N = 482), $p = .059$. Binary logistic regression was performed to assess the impact of gender on student self-reported grade; the model was not statistically significant, X^2 (1, N = 482) 3.85, $p = .073$. These results are consistent and suggest that gender does not predict student achievement.

Pedagogy-Related Findings

This study assessed pedagogy from a student preference perspective; that is, 20 questions on the survey instrument were used to determine a student’s learning preference, then the student’s learning preference was connected to his or her student achievement scores to investigate an association between the two; a detailed account of this process is presented in Chapter 3.

The relationship between gender and the composite variable Connected Knowledge was investigated using a Spearman rank order correlation coefficient. There was a statistically significant small positive correlation between the two variables, $r_S(478) = .170, p < .001$. Next, the Spearman rank order correlation coefficient for gender and the composite variable Separate Knowledge was investigated; there was a small negative correlation between the two variables, $r_S(478) = -.216, p < .001$. Independent-samples t tests were conducted to compare Connected Knowledge scores for males and females. There was a statistically significant difference in scores between males ($M = 52.65$, $SD = 7.69$) and females ($M = 55.14$, $SD = 7.50$), $t(478) = -3.585, p < .001$. Females had a higher mean score than males. The same test was conducted for Separate Knowledge; there was a statistically significant difference in the scores between males ($M = 46.37$, $SD = 7.74$) and females ($M = 42.91$, $SD = 8.30$), $t(478) = 4.70, p < .001$. Females had a lower mean score compared to males. Finally, binary logistic regression was performed to assess the relationship between pedagogy (the two composite variables Connected Knowledge and Separate Knowledge) and student self-reported grade. The model contained two independent variables: Connected Knowledge and Separate Knowledge. The model was not statistically significant, X^2 (2, $N = 476$) = 3.57, $p = .055$. These results suggest gender does predict pedagogical preference, and pedagogy alone does not predict students' perception of their achievement.

The Intersection of Gender and Pedagogy Findings

A binary logistic regression was performed to assess the impact of gender and pedagogy on student self-reported grades. The model contained two independent variables: gender and pedagogy (Connected Knowledge and Separate Knowledge). The full model containing both predictors was statistically significant, X^2 (3, $N = 475$) = 9.83, $p = .016$ for Connected Knowledge and $p = .023$ for gender; Separate Knowledge was not statistically significant ($p = .162$), indicating that the model was able to distinguish between respondent gender and Connected Knowledge pedagogical learning preference. The model as a whole explained between 2.0% (Cox and Snell R^2) and 8.8% (Nagelkerke R^2) of the variance in student self-reported grade and correctly classified 97.1% of the cases (adapted from Pallant, 2013, p. 186).

Discussion

Gender-Related Discussion

The literature review is dichotomous in its discussion about the relationship between gender and student self-reported grade; some scholars, such as Curren (2006), Else-Quest et al. (2010), and Zohar (2006) reported a relationship between these variables in their research; however, others scholars, such as Hill et al. (2010) and Tomasetto et al. (2011) did not find a relationship between gender and student achievement.

This study sample had gender diversity generally representative of the institution; there were 53.7% ($n = 259$) females and 46.2% ($n = 223$) males in the study. The findings of this study did not indicate a statistically significant relationship between gender and students' perception of their success; 45.6% ($n = 220$) of the females self-reported passing grades, while 51.4% (n = 248) of the males self reported a passing grade. In the Chi-square test of independence, the "gender*student achievement" output's *p* value was .059. The value of .59 is not statistically significant. This means that the proportion of female's self-reported grades is not significantly different from the proportion of male's self-reported grades. There appears to be no association between gender and self-reported grades. The results from this study are consistent and indicate no statistically significant relationship between gender and perceived student success.

Pedagogy-Related Discussion

Gender and pedagogical preference were related in this study; females preferred Connected Knowledge pedagogies and males preferred Separate Knowledge pedagogies. When the Spearman rank order correlation coefficient was calculated, there was a small positive, but significant correlation between females and preference for Connected Knowledge pedagogies, $r_s(478) = .170$, $p < .001$, and a small negative correlation, $r_s(478) = -.216$, $p < .001$, between females and preference for Separate Knowledge pedagogies. When independent-samples *t* tests were conducted to compare preference for Connected Knowledge scores for males and females, there was a statistically significant difference in scores between males ($M = 52.65$, $SD = 7.69$) and females ($M = 55.14$, $SD = 7.50$) $t(478) = -3.585$, $p < .001$). When the same test was conducted for preference for Separate Knowledge, there was a statistically significant difference in the scores between males ($M = 46.37$, $SD = 7.74$) and females ($M = 42.91$, $SD = 8.30$), $t(478) = 4.70$, $p < .001$. As with the Spearman rank order results, the independent-samples *t* tests indicated a statistically significant difference between the learning preferences of females and males in this study.

While this study assessed students' learning preferences, classroom teachers' pedagogical methods were not assessed; no survey question asked about the method of instruction that the student believed was being used in the class. Therefore, it cannot be known what pedagogical methods were being utilized in the surveyed classes.

The Intersection of Gender and Pedagogy Discussion

Consistent with research findings by Zohar (2006) and Zuga (1999), this study found a statistically significant result between the combined predictor variables gender and pedagogical preference (Connected Knowledge) when measured against the dependent variable student self-reported grade. Results of binary logistic regression for the combined predictor variables were statistically significant, X^2 (3, $N = 475$) 9.83, $p = .016$ for pedagogical preference for Connected Knowledge and $p = .023$ for gender. This finding suggests that females in this study had a higher self-reported grade when their preferred learning method was a Connected Knowledge pedagogy. This is also consistent with the theoretical framework *Women's Ways of Knowing* that undergirded this study. Belenky et al. (1986) suggested that, generally speaking, women and men have different ways of processing knowledge; their findings suggest that women more commonly use and prefer Connected Knowledge ways of knowing and males more commonly use and prefer Separate Knowledge ways of knowing. Belenky et al. (1986) did not suggest that either gender uses one of these learning styles exclusively, but rather that these are gender-related preferred learning styles.

Limitations of the Research Study's Results

Several limitations of this study are acknowledged. All of these limitations focus on Question 33 of the survey, used to form the dependent variable Student Achievement.

1. The use of student self-reported grades resulted in a heavily biased output. The use of self-reported grades could have led to some students' mistaken perception of success in their math class; it is unlikely that 97% of the students in the math classes surveyed passed the course with a grade of "C" or better.

2. The administration of the survey and collection of data in the 9th week of the semester was considered to be the best point for data collection; however, this timing could have led to the result discussed in the first limitation. In retrospect, it is reasonable to conclude that a much later date in the semester, perhaps as late as 2 weeks prior to the semester's end, would have been the best time to capture data for self-reported grade.

Recommendation for Practice

The results of this study indicate a preference for Connected Knowledge pedagogies. According to the literature (Opdenakker & Van Damme, 2006; Stipek et al., 2001; Zohar, 2006), most STEM classrooms use Separate Knowledge pedagogies. This difference in female learning preference and the common method of STEM instruction could partially explain the lack of female participation in certain STEM majors. Therefore, it is recommended that STEM faculty seek a greater understanding of their female students' learning preference. The lack of a representative female population in certain STEM majors should be of concern to STEM faculty. Those who wish to investigate this topic thoroughly could spearhead investigations into factors that contribute to this condition. Female advocacy groups both in academia and STEM professions could distribute literature that explains the challenges associated with pursuing coursework that may be presented predominantly using Separate Knowledge pedagogies. These advocacy groups could enter into partnerships with researchers attuned to this topic in an effort to provide information that helps females to formulate the best coping mechanisms to strengthen their chances of being successful in traditionally male domains such as those addressed in this study.

Recommendation for Policy Change

To the best of this researcher's knowledge, there are no policies currently in place that speak directly to the findings of this study. It is recommended that policy makers examine factors that contribute to the gender imbalance within STEM majors such as physics and engineering. If studies were commissioned and robust findings were produced that clearly identified the causal factors for the gender imbalance, recommendations for policy change would seem appropriate. Although the results of this study do not provide the statistical power to make such recommendations, the evidence provided by almost every academic institution about female participation in engineering and physics majors, as well as government data on female engineers and physicists, should be sufficient to encourage policy makers to investigate the reasons for their lack of participation.

Recommendations for Further Study

This quantitative research study was designed to link classroom pedagogy with female student self-reported grade, specifically to determine whether Connected Knowledge pedagogies could help to explain the gender gap in certain STEM majors, such as physics and engineering. The goal was to understand why certain STEM majors remain male domains, particularly whether there are unknown or unseen barriers, so-called structural roadblocks, that quietly give the message that females are not welcome or cannot succeed in these particular occupations. Future studies could seek to investigate a linkage in teacher's pedagogy and student's gender and achievement scores. The use of self-reported grades was acknowledged as a limitation in this study. Students were surveyed in the 9th week of a 16-week semester; it is now believed that self-reported grades would have been more accurate at a date later in the semester, perhaps as late as 2 weeks prior to the semester's end. Linking actual grades (e.g., for each assignment) and to each respondent is suggested. The goal is to capture the nuanced items that may contribute to the problem. With regard to the specific STEM majors that were the focus of this study, it is suggested that future studies sample multiple levels of prerequisite classes and multiple classes within the majors. The literature suggests that the higher the level of STEM class, the lower the female population. A future study could investigate the reason for the drop in female participation as courses progress toward higher levels.

Conclusion

The demand for STEM professionals is expected to grow in the foreseeable future (BLS, 2007). The American STEM work force is highly gendered; for example, the highest female participation in engineering noted to date was 18.8% (U.S. Department of Labor, Women's Bureau, 2012), even though females make up approximately 50% of the American population (U.S. Census Bureau, 2013a). An increase in female participation in STEM occupations would reduce the U.S. need for foreign-born STEM professionals. STEM professions are highly paid and prestigious; those members of society who hold these positions enjoy a secure financial and societal place (U.S. Department of Labor, Women's Bureau, 2013). However, barriers to female participation, persistence, and eventual employment in these particular STEM professions remain. This study investigated whether pedagogical methods might explain, at least in part, the reasons for this lack of female participation in these majors and occupations. The results indicated that gender itself did not predict student achievement, that females preferred to learn with Connected Knowledge pedagogies, and that, when taken together, gender and Connected Knowledge pedagogy produced a statistically significant indication of females' learning preference.

APPENDICES

APPENDIX A

ATTLS INSTRUMENT

Attitudes Toward Thinking and Learning Survey (ATTLS)

<u>This is a confidential survey; please do not write your name on the survey</u>

1. What is your gender (circle one)? Male Female
2. What is your age range (circle one)? 17 or less 18-20 21-23 24-26 27 or more
3. What is your ethnicity (circle one)? African-American Asian Caucasian/White Hispanic/Latin Native American/Alaskan Native Native Hawaiian/Pacific Islander Other (define) ____________
4. Do you have a disability that affects your ability to do math well? _______ If so, please describe.

____

5. What is your declared major (circle one)? Business Chemistry Computers Education Engineering Liberal Studies Nursing Physics Science Other (define) __________

Instructions: In this next section please rate the degree to which you agree with each statement using the following scale. Do NOT use decimals or fractions. Answer the questions quickly without dwelling too long on any question (i.e., go with your first reaction). Please do not change your responses to items once you have marked them.

Strongly Disagree	Somewhat Disagree	Slightly Disagree	Neither Agree Nor Disagree	Slightly Agree	Somewhat Agree	Strongly Agree
1	2	3	4	5	6	7

6. ________ When I encounter people whose opinions seem alien to me, I make a deliberate effort to "extend" myself into that person, to try to see how they could have those opinions.
7. ________ I like playing devil's advocate—arguing the opposite of what someone is saying.
8. ________ It's important for me to remove myself from analysis of something and remain as objective as possible.
9. ________ I can obtain insight into opinions that differ from mine through empathy.
10. ________ I tend to put myself in other people's shoes when discussing controversial issues, to see why they think the way they do.
11. ________ I try to listen to other people's position with a critical eye.
12. ________ I find that I can strengthen my own position through arguing with someone who disagrees with me.
13. ________ I'm more likely to try to understand someone else's opinion than to try to evaluate it.
14. ________ One could call my way of analyzing things "putting them on trial," because of how careful I am to consider all of the evidence.

Continued on next page

Strongly Disagree	Somewhat Disagree	Slightly Disagree	Neither Agree Nor Disagree	Slightly Agree	Somewhat Agree	Strongly Agree
1	2	3	4	5	6	7

15. ________ I try to think with people instead of against them.

16. ________ I often find myself arguing with the authors of books I read, trying to logically figure out why they're wrong.

17. ________ I have certain criteria I use in evaluating arguments.

18. ________ I try to "shoot holes" in what other people are saying to help them clarify their arguments.

19. ________ I feel that the best way for me to achieve my own identity is to interact with a variety of other people.

20. ________ I am always interested in knowing why people say and believe the things they do.

21. ________ I spend time figuring out what's "wrong" with things; for example, I'll look for something in a literary interpretation that isn't argued well enough.

22. ________ I enjoy hearing the opinions of people who come from backgrounds different from mine—it helps me understand how the same things can be seen in such different ways.

23. ________ I value the use of logic and reason over the incorporation of my own concerns when solving problems.

24. ________ The most important part of my education has been learning to understand people who are very different from me.

25. ________ I like to understand where other people are "coming from," what experiences have led them to feel the way they do.

26. ________ I prefer learning math using the formula method. The teacher writes the problem on the board and works out the problem while students watch and ask questions.

27. ________ I prefer learning math using the story telling method. The teacher tells a story of how the problem relates to the world, and how I might use the sample math problem in real life.

28. ________ I prefer learning math using the demonstration method. The teacher uses teaching aids like 3-demenstional objects to explain the math problem.

29. ________ I prefer learning math using the group method. The class breaks into small groups of about 3 students, the group solves the problem together, and then explains to the class how they solved the problem.

30. ________ I believe math is an easy subject.

31. ________ I believe math comes easier for some people more than others.

32. ________ I used to be terrible at math, then something "clicked" and suddenly I understood it.

Continued on next page

<u>This section does not use the 1-7 scale. Please answer the questions to the best of your ability.</u>

33. What grade and/or percentage do you think you will get in this class? ______________________

34. What was the last math class you took prior to this one? ______________________

35. What grade and/or percentage did you get in that math class? ______________________

36. Was it necessary to repeat any pre-requisite math class on the way to your major? If so, please list each one and the number of times you repeated it. ______________________

37. Compared to other general education classes like written communication, oral communication, health, and so on, how would you rate your math performance (circle one)?

Much worse   A little worse   About the same   A little better   Much better

38. What part of math class do you usually score highest in (circle one)?

Homework   Quizzes   Exams   Other (define): ______________

39. What part of math class do you usually score lowest in (circle one)?

Homework   Quizzes   Exams   Other (define): ______________

40. Concerning questions 38 and 39, what do you think are the most important factors for you scoring the way you did? What makes you do better (or worse) in one category than another?

____

____

____

____

____

41. Please recall all the previous math classes you've ever taken; there should be one math class that sticks out in your mind as being the "best." Now, thinking about that "best" math class, **please describe as many details as possible about that math class; what made it "the best math class you ever took?"** I have provided a few questions to get you started.

APPENDIX E

What grade were you in? ______________ What math subject was it? ______________

Was there something unique that was going on in your life at the time? ______________

Was the teacher a man or a woman? ______________ Do you think the sex (gender) of the

Permission Letters

teacher made a difference? Why or why not? ______________________

Continued on next page

Please continue your answer to question 41 below. "41. Please recall all the previous math classes you've ever taken; there should be one math class that sticks out in your mind as being the "best." Now, thinking about that "best" math class, **please describe as many details as possible about that math class; what made it 'the best math class you ever took?'"**

Thank you for completing the survey. Your input is valuable and sincerely appreciated!

APPENDIX B

LETTER TO MATH PROFESSORS

Letter to math professor that will accompany the main packet

Dear Professor,

Thank you for your willingness to administer the attached surveys to your students; it is sincerely appreciated! The attached packet has surveys with consent forms attached. The total time to complete the survey should be less than 30 minutes. Prior to completing the survey the students should read the consent form, then if they agree to participate, sign and date the consent form. They only need to sign and date the consent form that will come back to me; the second consent form is a copy for the student to keep.

Each packet with its surveys and consent forms should be used in one class only; please do not put surveys and consent forms from more than one class in an envelope. Please administer the survey to as many students and classes as you can, the more the better. Once the surveys are completed, place them back in their respective envelope and return them to me.

I have provided a gift for you, the educator, as a token of my appreciation for your willingness to help. If you have any questions please feel free to call or write.

Sincerely,

Richard Rodman M.A.Ed.
Cellular number: (xxx) xxx-xxxx
Email: richard.rodman@rcc.edu

APPENDIX C

SCRIPT

Script for math professor to read to students prior to handing out packets

You have been asked to participate in a research study for a doctoral student in the College of Education. The study focuses on student success in STEM majors, especially math students.

If you agree to participate, the entire process should take less than 30 minutes.

In order to participate in the study you must be 18 or older. If you meet the criteria and wish to participate, you will read the informed consent form, sign both copies, and then complete the survey. Of course, you do not have to participate, and to opt out, you can simply leave both the informed consent form and survey blank.

In just a moment I will pass out a packet with two consent forms and one survey per person. If you are willing to participate, please read the informed consent form, and sign both copies. Keep one copy for yourself, and submit one copy in the envelope labeled “consent form.” You can turn in the informed consent and survey at the same time.

Once you have read and signed the informed consent forms, please complete the survey. If there are any questions on the survey that you do not want to answer or feel uncomfortable answering, please feel free to leave them blank.

All of your answers will be completely confidential because both the informed consent and survey will be placed in separate envelopes, and your name does not appear anywhere on the survey.

If you do not want to participate in the study, then simply do not sign the informed consent form and do not complete the survey.

Again, you are not obligated to participate in the study; you can turn in a blank informed consent and survey should you choose not to participate.

Two envelopes are provided, one for the consent forms and one for the surveys. Both of these will be place in “neutral locations” in the classroom.

Once you have completed the survey, or have chosen to leave it blank, please place it in the envelope labeled “survey.”

The last student to put their survey and consent form into the envelopes will seal each envelope. Your math professor will return these sealed envelopes to me.

Any questions?

APPENDIX D

INFORMED CONSENT

Informed Consent Form

You have been asked to participate in a research study conducted by Richard Rodman, M.A.Ed., from the College of Education at California State University, Long Beach. This study will contribute to his doctoral dissertation. You were selected as a possible participant in this study because of your role as a student in a college-level math course.

PURPOSE OF THE STUDY

The purpose of the research study is to determine the student's experience in a college-level math course.

PROCEDURES

If you agree to participate in this study, you will do the following things:

1. Read the Informed Consent
2. Complete the attached "**Attitudes Toward Thinking and Learning Survey**."

POTENTIAL RISKS AND DISCOMFORTS

1. The participant might experience some level of psychological distress from a question they are asked to answer.
2. The participant might think their classroom grade or performance might be affected by participation, or lack thereof, in the study.
3. Steps have been made to maintain anonymity, but the anonymity cannot be completely guaranteed.

POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

1. The research study results are directed toward members of the academic community charged with writing educational policy for the state of California.
2. The research is conducted in an effort to discover the beliefs that influence math success.

There is no expected personal benefit to students who participate in the research study.

PAYMENT FOR PARTICIPATION

There is no payment for the participation in the research study.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law.

The following methods of confidentiality will be used.

1. Make the survey anonymous.
2. This consent form and the survey will be separated.

3. Both surveys and consent forms will be placed in separate envelopes and sealed before returning the envelopes to the classroom professor.
4. Once the dissertation is complete, all surveys will be destroyed.

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequence of any kind. Participation or non-participation will not affect your treatment, care, grade or any other personal consideration or right you usually expect. You may also refuse to answer any questions you do not want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which in the opinion of the researcher warrant doing so.

IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact the researcher, Richard Rodman at (714) 460-XXXX, or his faculty advisor, Dr. John Murray at (562) 985-XXXX.

RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue your participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact the Office of University Research, CSU Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840; Telephone: (562) 985-XXXX or email to research@csulb.edu.

SIGNATURE OF RESEARCH SUBJECT

I understand the procedures and conditions of my participation described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

____

Name of Subject (student)

____

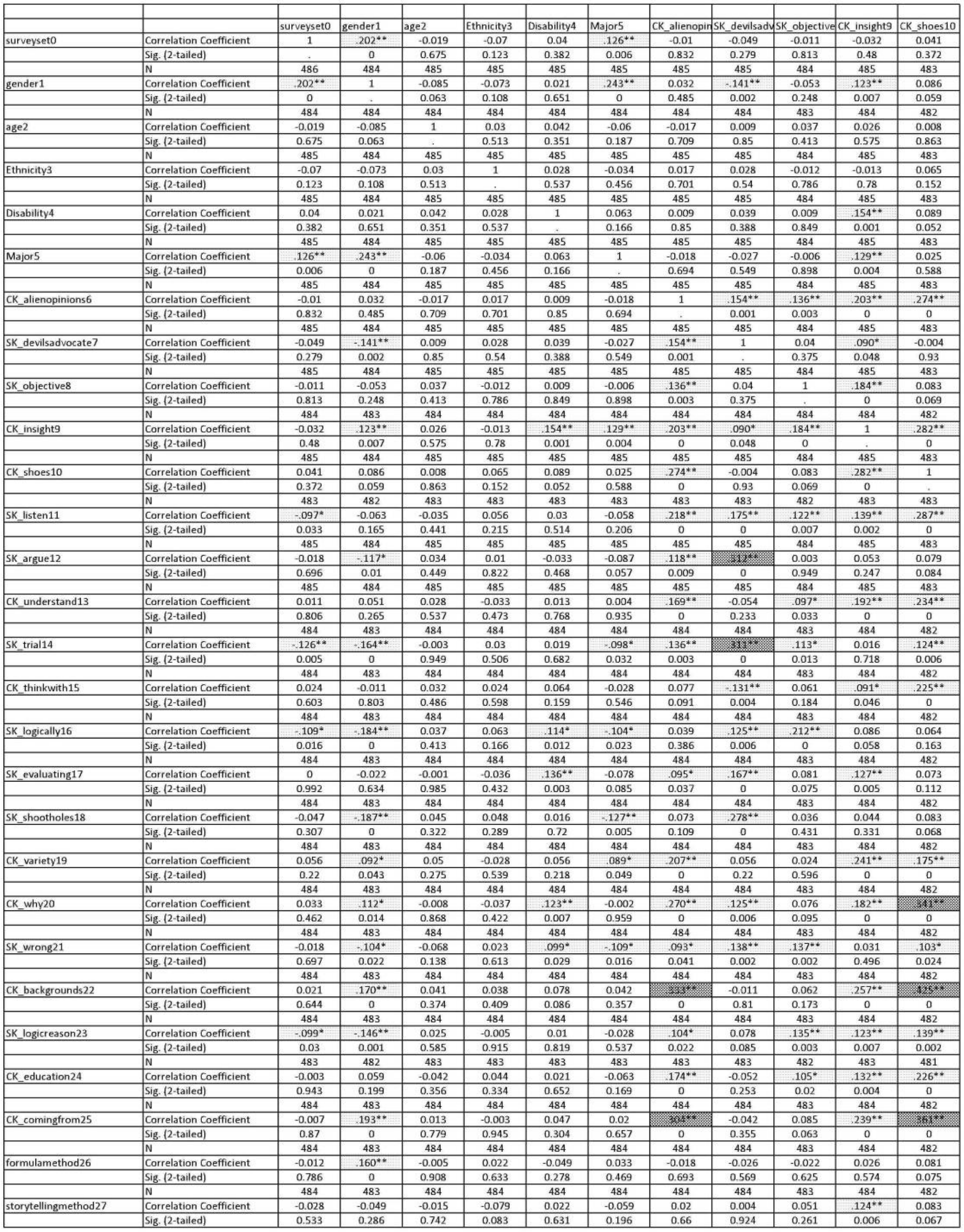
Signature of Subject (student)

____

Date

APPENDIX E

SPEARMAN RHO CORRELATIONS



		surveyset0	gender1	age2	Ethnicity3	Disability4	Major5	CK_alienopin	SK_devilsadv	SK_objective	CK_insight9	CK_shoes10
surveyset0	Correlation Coefficient	1	.202**	-0.019	-0.07	0.04	.126**	-0.01	-0.049	-0.011	-0.032	0.041
	Sig. (2-tailed)	.	0	0.675	0.123	0.382	0.006	0.832	0.279	0.813	0.48	0.372
	N	486	484	485	485	485	485	485	485	484	485	483
gender1	Correlation Coefficient	.202**	1	-0.085	-0.073	0.021	.243**	0.032	-.141**	-0.053	.123**	0.086
	Sig. (2-tailed)	0	.	0.063	0.108	0.651	0	0.485	0.002	0.248	0.007	0.059
	N	484	484	484	484	484	484	484	484	483	484	482
age2	Correlation Coefficient	-0.019	-0.085	1	0.03	0.042	-0.06	-0.017	0.009	0.037	0.026	0.008
	Sig. (2-tailed)	0.675	0.063	.	0.513	0.351	0.187	0.709	0.85	0.413	0.575	0.863
	N	485	484	485	485	485	485	485	485	484	485	483
Ethnicity3	Correlation Coefficient	-0.07	-0.073	0.03	1	0.028	-0.034	0.017	0.028	-0.012	-0.013	0.065
	Sig. (2-tailed)	0.123	0.108	0.513	.	0.537	0.456	0.701	0.54	0.786	0.78	0.152
	N	485	484	485	485	485	485	485	485	484	485	483
Disability4	Correlation Coefficient	0.04	0.021	0.042	0.028	1	0.063	0.009	0.039	0.009	.154**	0.089
	Sig. (2-tailed)	0.382	0.651	0.351	0.537	.	0.166	0.85	0.388	0.849	0.001	0.052
	N	485	484	485	485	485	485	485	485	484	485	483
Major5	Correlation Coefficient	.126**	.243**	-0.06	-0.034	0.063	1	-0.018	-0.027	-0.006	.129**	0.025
	Sig. (2-tailed)	0.006	0	0.187	0.456	0.166	.	0.694	0.549	0.898	0.004	0.588
	N	485	484	485	485	485	485	485	485	484	485	483
CK_alienopinions6	Correlation Coefficient	-0.01	0.032	-0.017	0.017	0.009	-0.018	1	.154**	.136**	.203**	.274**
	Sig. (2-tailed)	0.832	0.485	0.709	0.701	0.85	0.694	.	0.001	0.003	0	0
	N	485	484	485	485	485	485	485	485	484	485	483
SK_devilsadvocate7	Correlation Coefficient	-0.049	-.141**	0.009	0.028	0.039	-0.027	.154**	1	0.04	.090*	-0.004
	Sig. (2-tailed)	0.279	0.002	0.85	0.54	0.388	0.549	0.001	.	0.375	0.048	0.93
	N	485	484	485	485	485	485	485	485	484	485	483
SK_objective8	Correlation Coefficient	-0.011	-0.053	0.037	-0.012	0.009	-0.006	.136**	0.04	1	.184**	0.083
	Sig. (2-tailed)	0.813	0.248	0.413	0.786	0.849	0.898	0.003	0.375	.	0	0.069
	N	484	483	484	484	484	484	484	484	484	484	482
CK_insight9	Correlation Coefficient	-0.032	.123**	0.026	-0.013	.154**	.129**	.203**	.090*	.184**	1	.282**
	Sig. (2-tailed)	0.48	0.007	0.575	0.78	0.001	0.004	0	0.048	0	.	0
	N	485	484	485	485	485	485	485	485	484	485	483
CK_shoes10	Correlation Coefficient	0.041	0.086	0.008	0.065	0.089	0.025	.274**	-0.004	0.083	.282**	1
	Sig. (2-tailed)	0.372	0.059	0.863	0.152	0.052	0.588	0	0.93	0.069	0	.
	N	483	482	483	483	483	483	483	483	482	483	483
SK_listen11	Correlation Coefficient	-.097*	-0.063	-0.035	0.056	0.03	-0.058	.218**	.175**	.122**	.139**	.287**
	Sig. (2-tailed)	0.033	0.165	0.441	0.215	0.514	0.206	0	0	0.007	0.002	0
	N	485	484	485	485	485	485	485	485	484	485	483
SK_argue12	Correlation Coefficient	-0.018	-.117*	0.034	0.01	-0.033	-0.087	.118**	.312**	0.003	0.053	0.079
	Sig. (2-tailed)	0.696	0.01	0.449	0.822	0.468	0.057	0.009	0	0.949	0.247	0.084
	N	485	484	485	485	485	485	485	485	484	485	483
CK_understand13	Correlation Coefficient	0.011	0.051	0.028	-0.033	0.013	0.004	.169**	-0.054	.097*	.192**	.234**
	Sig. (2-tailed)	0.806	0.265	0.537	0.473	0.768	0.935	0	0.233	0.033	0	0
	N	484	483	484	484	484	484	484	484	483	484	482
SK_trial14	Correlation Coefficient	-.126**	-.164**	-0.003	0.03	0.019	-.098*	.136**	.311**	.113*	0.016	.124**
	Sig. (2-tailed)	0.005	0	0.949	0.506	0.682	0.032	0.003	0	0.013	0.718	0.006
	N	484	483	484	484	484	484	484	484	483	484	482
CK_thinkwith15	Correlation Coefficient	0.024	-0.011	0.032	0.024	0.064	-0.028	0.077	-.131**	0.061	.091*	.225**
	Sig. (2-tailed)	0.603	0.803	0.486	0.598	0.159	0.546	0.091	0.004	0.184	0.046	0
	N	484	483	484	484	484	484	484	484	483	484	482
SK_logically16	Correlation Coefficient	-.109*	-.184**	0.037	0.063	.114*	-.104*	0.039	.125**	.212**	0.086	0.064
	Sig. (2-tailed)	0.016	0	0.413	0.166	0.012	0.023	0.386	0.006	0	0.058	0.163
	N	484	483	484	484	484	484	484	484	483	484	482
SK_evaluating17	Correlation Coefficient	0	-0.022	-0.001	-0.036	.136**	-0.078	.095*	.167**	0.081	.127**	0.073
	Sig. (2-tailed)	0.992	0.634	0.985	0.432	0.003	0.085	0.037	0	0.075	0.005	0.112
	N	484	483	484	484	484	484	484	484	483	484	482
SK_shootholes18	Correlation Coefficient	-0.047	-.187**	0.045	0.048	0.016	-.127**	0.073	.278**	0.036	0.044	0.083
	Sig. (2-tailed)	0.307	0	0.322	0.289	0.72	0.005	0.109	0	0.431	0.331	0.068
	N	484	483	484	484	484	484	484	484	483	484	482
CK_variety19	Correlation Coefficient	0.056	.092*	0.05	-0.028	0.056	.089*	.207**	0.056	0.024	.241**	.175**
	Sig. (2-tailed)	0.22	0.043	0.275	0.539	0.218	0.049	0	0.22	0.596	0	0
	N	484	483	484	484	484	484	484	484	483	484	482
CK_why20	Correlation Coefficient	0.033	.112*	-0.008	-0.037	.123**	-0.002	.270**	.125**	0.076	.182**	.341**
	Sig. (2-tailed)	0.462	0.014	0.868	0.422	0.007	0.959	0	0.006	0.095	0	0
	N	484	483	484	484	484	484	484	484	483	484	482
SK_wrong21	Correlation Coefficient	-0.018	-.104*	-0.068	0.023	.099*	-.109*	.093*	.138**	.137**	0.031	.103*
	Sig. (2-tailed)	0.697	0.022	0.138	0.613	0.029	0.016	0.041	0.002	0.002	0.496	0.024
	N	484	483	484	484	484	484	484	484	483	484	482
CK_backgrounds22	Correlation Coefficient	0.021	.170**	0.041	0.038	0.078	0.042	.333**	-0.011	0.062	.257**	.425**
	Sig. (2-tailed)	0.644	0	0.374	0.409	0.086	0.357	0	0.81	0.173	0	0
	N	484	483	484	484	484	484	484	484	483	484	482
SK_logicreason23	Correlation Coefficient	-.099*	-.146**	0.025	-0.005	0.01	-0.028	.104*	0.078	.135**	.123**	.139**
	Sig. (2-tailed)	0.03	0.001	0.585	0.915	0.819	0.537	0.022	0.085	0.003	0.007	0.002
	N	483	482	483	483	483	483	483	483	482	483	481
CK_education24	Correlation Coefficient	-0.003	0.059	-0.042	0.044	0.021	-0.063	.174**	-0.052	.105*	.132**	.226**
	Sig. (2-tailed)	0.943	0.199	0.356	0.334	0.652	0.169	0	0.253	0.02	0.004	0
	N	484	483	484	484	484	484	484	484	483	484	482
CK_comingfrom25	Correlation Coefficient	-0.007	.193**	0.013	-0.003	0.047	0.02	.304**	-0.042	0.085	.239**	.361**
	Sig. (2-tailed)	0.87	0	0.779	0.945	0.304	0.657	0	0.355	0.063	0	0
	N	484	483	484	484	484	484	484	484	483	484	482
formulamethod26	Correlation Coefficient	-0.012	.160**	-0.005	0.022	-0.049	0.033	-0.018	-0.026	-0.022	0.026	0.081
	Sig. (2-tailed)	0.786	0	0.908	0.633	0.278	0.469	0.693	0.569	0.625	0.574	0.075
	N	484	483	484	484	484	484	484	484	483	484	482
storytellingmethod27	Correlation Coefficient	-0.028	-0.049	-0.015	-0.079	0.022	-0.059	0.02	0.004	0.051	.124**	0.083
	Sig. (2-tailed)	0.533	0.286	0.742	0.083	0.631	0.196	0.66	0.924	0.261	0.006	0.067

	N	483	482	483	483	483	483	483	483	482	483	481
demonstrationmethod28	Correlation Coefficient	0.023	0.011	0.043	-0.058	0.058	0.016	-0.022	-0.032	0.01	0.062	.122**
	Sig. (2-tailed)	0.607	0.808	0.344	0.206	0.202	0.724	0.624	0.48	0.821	0.176	0.008
	N	484	483	484	484	484	484	484	484	483	484	482
groupmethod29	Correlation Coefficient	-0.035	-0.027	-0.026	-0.036	.091*	0.001	0.04	0.07	0.075	0.05	.112*
	Sig. (2-tailed)	0.441	0.553	0.568	0.424	0.044	0.975	0.374	0.123	0.1	0.269	0.014
	N	484	483	484	484	484	484	484	484	483	484	482
easy30	Correlation Coefficient	-0.012	-.119**	0.008	0.078	-0.067	-0.054	0.044	0.004	-0.015	0.033	-0.037
	Sig. (2-tailed)	0.794	0.009	0.868	0.086	0.143	0.238	0.333	0.926	0.746	0.464	0.419
	N	484	483	484	484	484	484	484	484	483	484	482
easyforsome31	Correlation Coefficient	0.017	0.028	0.016	-0.053	0.057	.105*	-0.054	-0.042	0.005	.115*	.095*
	Sig. (2-tailed)	0.704	0.543	0.72	0.24	0.208	0.021	0.234	0.36	0.918	0.011	0.036
	N	484	483	484	484	484	484	484	484	483	484	482
terriblemath32	Correlation Coefficient	.098*	0.063	-0.019	-.131**	0.011	0.033	0.038	0.008	-0.012	0.041	-0.006
	Sig. (2-tailed)	0.032	0.169	0.673	0.004	0.816	0.467	0.398	0.867	0.8	0.37	0.901
	N	484	483	484	484	484	484	484	484	483	484	482
thisgrade33	Correlation Coefficient	.102*	0.047	0.008	0.084	.117*	-0.029	-0.088	-0.002	-0.018	-0.047	0.042
	Sig. (2-tailed)	0.026	0.302	0.86	0.065	0.01	0.521	0.053	0.965	0.689	0.298	0.36
	N	483	482	483	483	483	483	483	483	482	483	481
lastmathclass34	Correlation Coefficient	0.078	0.038	-0.063	-0.04	-0.042	0.018	0.025	-0.001	-0.023	0.029	-0.035
	Sig. (2-tailed)	0.088	0.402	0.169	0.379	0.36	0.701	0.583	0.978	0.617	0.523	0.443
	N	480	479	480	480	480	480	480	480	479	480	478
mathgrade35	Correlation Coefficient	-0.083	0.001	-0.012	0.019	-0.011	-.121**	-0.016	-0.015	0.026	0.027	-0.019
	Sig. (2-tailed)	0.068	0.991	0.794	0.672	0.81	0.008	0.725	0.742	0.567	0.554	0.672
	N	482	481	482	482	482	482	482	482	481	482	480
mathrepeated36	Correlation Coefficient	-0.01	0.015	.095*	-0.013	0.008	-0.065	0.077	-0.009	-0.069	0.03	-0.023
	Sig. (2-tailed)	0.834	0.748	0.037	0.774	0.863	0.152	0.091	0.848	0.131	0.506	0.611
	N	485	484	485	485	485	485	485	485	484	485	483
mathcomparison37	Correlation Coefficient	-0.026	-.093*	-0.008	0.016	-0.088	-0.026	0.014	-0.049	-0.001	-0.02	-0.047
	Sig. (2-tailed)	0.575	0.041	0.865	0.722	0.053	0.568	0.753	0.28	0.977	0.663	0.308
	N	483	482	483	483	483	483	483	483	482	483	481
mathhighscore38	Correlation Coefficient	-0.08	-.219**	0.043	0.066	0.018	-.111*	0.079	0.036	.112*	0.067	0.071
	Sig. (2-tailed)	0.08	0	0.343	0.149	0.7	0.015	0.083	0.431	0.014	0.141	0.12
	N	484	483	484	484	484	484	484	484	483	484	482
mathlowscore39	Correlation Coefficient	.096*	.142**	-0.031	0.061	0.028	0.056	-0.041	-0.049	-0.081	-0.035	-0.002
	Sig. (2-tailed)	0.035	0.002	0.497	0.179	0.539	0.219	0.369	0.281	0.074	0.442	0.972
	N	484	483	484	484	484	484	484	484	483	484	482
qualgrade41a	Correlation Coefficient	-.096*	0	0.048	-0.058	0	0.027	0.02	-0.003	0.005	0.036	0.018
	Sig. (2-tailed)	0.038	0.998	0.306	0.212	0.992	0.564	0.669	0.947	0.921	0.432	0.702
	N	466	465	466	466	466	466	466	466	465	466	464
qualcourse41b	Correlation Coefficient	-0.05	-0.039	-.110*	-0.008	-0.075	-0.014	0.034	-0.029	-0.004	-0.013	0.002
	Sig. (2-tailed)	0.272	0.398	0.016	0.866	0.101	0.756	0.455	0.522	0.923	0.777	0.966
	N	483	482	483	483	483	483	483	483	482	483	481
qualgender41d	Correlation Coefficient	0.062	0.067	0.008	-0.058	0.063	0.01	0.022	-.101*	-0.006	0.033	0.025
	Sig. (2-tailed)	0.178	0.142	0.866	0.202	0.168	0.824	0.632	0.026	0.887	0.476	0.578
	N	482	481	482	482	482	482	482	482	481	482	480
qualgendiff41e	Correlation Coefficient	-0.074	0.018	-0.025	0.039	.189**	0.043	-0.03	0.084	0.028	0.062	0.005
	Sig. (2-tailed)	0.106	0.698	0.58	0.39	0	0.35	0.516	0.066	0.534	0.173	0.912
	N	483	482	483	483	483	483	483	483	482	483	481
Connected Knowledge	Correlation Coefficient	0.022	.170**	0.012	0.006	.105*	0.045	.510**	0.019	.148**	.466**	.588**
	Sig. (2-tailed)	0.631	0	0.792	0.9	0.021	0.322	0	0.671	0.001	0	0
	N	481	480	481	481	481	481	481	481	480	481	481
Seperate Knowledge	Correlation Coefficient	-.093*	-.216**	0.009	0.046	0.068	-.126**	.209**	.523**	.317**	.152**	.166**
	Sig. (2-tailed)	0.042	0	0.837	0.315	0.138	0.006	0	0	0	0.001	0
	N	481	480	481	481	481	481	481	481	481	481	479
Student Acheivement	Correlation Coefficient	-0.042	-0.086	0.026	-0.008	-0.077	-0.071	.113*	0.02	-0.018	0.015	0.024
	Sig. (2-tailed)	0.351	0.059	0.574	0.865	0.091	0.117	0.013	0.667	0.701	0.735	0.602
	N	483	482	483	483	483	483	483	483	482	483	481
Class Type	Correlation Coefficient	.976**	.197**	-0.016	-0.081	0.017	.135**	-0.013	-0.056	0.002	-0.045	0.04
	Sig. (2-tailed)	0	0	0.719	0.073	0.712	0.003	0.779	0.222	0.959	0.326	0.375
	N	486	484	485	485	485	485	485	485	484	485	483
class name	Correlation Coefficient	-.310**	-.139**	.135**	-0.014	0.035	-0.058	0.006	0.056	0.018	0.066	-0.019
	Sig. (2-tailed)	0	0.002	0.003	0.755	0.444	0.201	0.9	0.219	0.69	0.149	0.678
	N	486	484	485	485	485	485	485	485	484	485	483
Gender Recode	Correlation Coefficient	.202**	1.000**	-0.085	-0.073	0.021	.243**	0.032	-.141**	-0.053	.123**	0.086
	Sig. (2-tailed)	0	.	0.063	0.108	0.651	0	0.485	0.002	0.248	0.007	0.059
	N	484	484	484	484	484	484	484	484	483	484	482
thisgrade33.1	Correlation Coefficient	-0.119	0.084	-0.049	-.176*	-0.107	0.053	.183*	-0.084	0.068	-0.028	-0.019
	Sig. (2-tailed)	0.143	0.303	0.546	0.029	0.187	0.512	0.024	0.303	0.405	0.733	0.814
	N	153	153	153	153	153	153	153	153	152	153	153
A_Grade	Correlation Coefficient	-.098*	-0.042	-0.015	-.095*	-0.031	0.063	0.084	-0.001	0.009	0.047	-0.008
	Sig. (2-tailed)	0.031	0.357	0.75	0.038	0.494	0.17	0.066	0.978	0.849	0.304	0.854
	N	483	482	483	483	483	483	483	483	482	483	481
B_Grade	Correlation Coefficient	0.026	0.015	0.011	0.042	-.116*	-0.059	-0.031	0.003	0.016	-0.013	-0.054
	Sig. (2-tailed)	0.57	0.745	0.816	0.359	0.011	0.195	0.501	0.955	0.733	0.777	0.238
	N	483	482	483	483	483	483	483	483	482	483	481
C_Grade	Correlation Coefficient	0.055	-0.007	0.013	0.047	.133**	-0.025	-0.008	0.006	-0.033	-0.027	0.079
	Sig. (2-tailed)	0.228	0.884	0.781	0.308	0.003	0.59	0.867	0.898	0.468	0.548	0.085
	N	483	482	483	483	483	483	483	483	482	483	481

SK_listen11	SK_argue12	CK_understa	SK_trial14	CK_thinkwith	SK_logically1	SK_evaluatin	SK_shoothol	CK_variety19	CK_why20	SK_wrong21	CK_backgrou	SK_logicreas	CK_educatio	CK_comingfr
-.097*	-0.018	0.011	-.126**	0.024	-.109*	0	-0.047	0.056	0.033	-0.018	0.021	-.099*	-0.003	-0.007
0.033	0.696	0.806	0.005	0.603	0.016	0.992	0.307	0.22	0.462	0.697	0.644	0.03	0.943	0.87
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
-0.063	-.117*	0.051	-.164**	-0.011	-.184**	-0.022	-.187**	.092*	.112*	-.104*	.170**	-.146**	0.059	.193**
0.165	0.01	0.265	0	0.803	0	0.634	0	0.043	0.014	0.022	0	0.001	0.199	0
484	484	483	483	483	483	483	483	483	483	483	483	482	483	483
-0.035	0.034	0.028	-0.003	0.032	0.037	-0.001	0.045	0.05	-0.008	-0.068	0.041	0.025	-0.042	0.013
0.441	0.449	0.537	0.949	0.486	0.413	0.985	0.322	0.275	0.868	0.138	0.374	0.585	0.356	0.779
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
0.056	0.01	-0.033	0.03	0.024	0.063	-0.036	0.048	-0.028	-0.037	0.023	0.038	-0.005	0.044	-0.003
0.215	0.822	0.473	0.506	0.598	0.166	0.432	0.289	0.539	0.422	0.613	0.409	0.915	0.334	0.945
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
0.03	-0.033	0.013	0.019	0.064	.114*	.136**	0.016	0.056	.123**	.099*	0.078	0.01	0.021	0.047
0.514	0.468	0.768	0.682	0.159	0.012	0.003	0.72	0.218	0.007	0.029	0.086	0.819	0.652	0.304
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
-0.058	-0.087	0.004	-.098*	-0.028	-.104*	-0.078	-.127**	.089*	-0.002	-.109*	0.042	-0.028	-0.063	0.02
0.206	0.057	0.935	0.032	0.546	0.023	0.085	0.005	0.049	0.959	0.016	0.357	0.537	0.169	0.657
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
.218**	.118**	.169**	.136**	0.077	0.039	.095*	0.073	.207**	.270**	.093*	.333**	.104*	.174**	.304**
0	0.009	0	0.003	0.091	0.386	0.037	0.109	0	0	0.041	0	0.022	0	0
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
.175**	.312**	-0.054	.311**	-.131**	.125**	.167**	.278**	0.056	.125**	.138**	-0.011	0.078	-0.052	-0.042
0	0	0.233	0	0.004	0.006	0	0	0.22	0.006	0.002	0.81	0.085	0.253	0.355
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
.122**	0.003	.097*	.113*	0.061	.212**	0.081	0.036	0.024	0.076	.137**	0.062	.135**	.105*	0.085
0.007	0.949	0.033	0.013	0.184	0	0.075	0.431	0.596	0.095	0.002	0.173	0.003	0.02	0.063
484	484	483	483	483	483	483	483	483	483	483	483	482	483	483
.139**	0.053	.192**	0.016	.091*	0.086	.127**	0.044	.241**	.182**	0.031	.257**	.123**	.132**	.239**
0.002	0.247	0	0.718	0.046	0.058	0.005	0.331	0	0	0.496	0	0.007	0.004	0
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
.287**	0.079	.234**	.124**	.225**	0.064	0.073	0.083	.175**	.341**	.103*	.425**	.139**	.226**	.361**
0	0.084	0	0.006	0	0.163	0.112	0.068	0	0	0.024	0	0.002	0	0
483	483	482	482	482	482	482	482	482	482	482	482	481	482	482
1	.276**	.116*	.282**	0.042	.106*	.160**	.170**	.090*	.199**	.140**	.252**	.218**	.132**	.226**
.	0	0.011	0	0.354	0.02	0	0	0.047	0	0.002	0	0	0.004	0
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
.276**	1	0.033	.245**	-.122**	.184**	.146**	.314**	.130**	.091*	.216**	0.04	.095*	0.05	-0.015
0	.	0.468	0	0.007	0	0.001	0	0.004	0.045	0	0.382	0.037	0.271	0.75
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
.116*	0.033	1	-0.011	.282**	0.061	.117*	-0.038	0.085	.139**	.111*	.230**	.123**	.245**	.283**
0.011	0.468	.	0.812	0	0.18	0.01	0.41	0.062	0.002	0.014	0	0.007	0	0
484	484	484	483	483	483	483	483	483	483	483	483	482	483	483
.282**	.245**	-0.011	1	-0.007	.281**	.222**	.316**	0.055	.236**	.315**	0.087	.258**	.114*	0.07
0	0	0.812	.	0.878	0	0	0	0.229	0	0	0.055	0	0.012	0.122
484	484	483	484	483	483	483	483	483	483	483	483	482	483	483
0.042	-.122**	.282**	-0.007	1	.100*	0.076	-0.073	.093*	.143**	0.074	.146**	0.086	.205**	.234**
0.354	0.007	0	0.878	.	0.027	0.095	0.111	0.04	0.002	0.103	0.001	0.059	0	0
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.106*	.184**	0.061	.281**	.100*	1	.284**	.228**	0.035	0.062	.366**	0.056	.193**	.107*	0
0.02	0	0.18	0	0.027	.	0	0	0.437	0.171	0	0.219	0	0.019	0.992
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.160**	.146**	.117*	.222**	0.076	.284**	1	.354**	.217**	.167**	.246**	.096*	.108*	.196**	.133**
0	0.001	0.01	0	0.095	0	.	0	0	0	0	0.036	0.018	0	0.003
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.170**	.314**	-0.038	.316**	-0.073	.228**	.354**	1	.232**	.150**	.293**	.106*	.190**	0.076	0.046
0	0	0.41	0	0.111	0	0	.	0	0.001	0	0.02	0	0.097	0.315
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.090*	.130**	0.085	0.055	.093*	0.035	.217**	.232**	1	.464**	.142**	.366**	.092*	.232**	.257**
0.047	0.004	0.062	0.229	0.04	0.437	0	0	.	0	0.002	0	0.043	0	0
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.199**	.091*	.139**	.236**	.143**	0.062	.167**	.150**	.464**	1	.235**	.495**	.233**	.231**	.417**
0	0.045	0.002	0	0.002	0.171	0	0.001	0	.	0	0	0	0	0
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.140**	.216**	.111*	.315**	0.074	.366**	.246**	.293**	.142**	.235**	1	.175**	.265**	.185**	.168**
0.002	0	0.014	0	0.103	0	0	0	0.002	0	.	0	0	0	0
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.252**	0.04	.230**	0.087	.146**	0.056	.096*	.106*	.366**	.495**	.175**	1	.240**	.387**	.562**
0	0.382	0	0.055	0.001	0.219	0.036	0.02	0	0	0	.	0	0	0
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.218**	.095*	.123**	.258**	0.086	.193**	.108*	.190**	.092*	.233**	.265**	.240**	1	.137**	.174**
0	0.037	0.007	0	0.059	0	0.018	0	0.043	0	0	0	.	0.003	0
483	483	482	482	483	483	483	483	483	483	483	483	483	483	483
.132**	0.05	.245**	.114*	.205**	.107*	.196**	0.076	.232**	.231**	.185**	.387**	.137**	1	.544**
0.004	0.271	0	0.012	0	0.019	0	0.097	0	0	0	0	0.003	.	0
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.226**	-0.015	.283**	0.07	.234**	0	.133**	0.046	.257**	.417**	.168**	.562**	.174**	.544**	1
0	0.75	0	0.122	0	0.992	0.003	0.315	0	0	0	0	0	0	.
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.114*	0.062	0.076	0.067	.096*	-0.02	0.048	0.079	0.087	.142**	0.009	.181**	0.083	.119**	.218**
0.012	0.176	0.094	0.144	0.035	0.665	0.295	0.083	0.055	0.002	0.844	0	0.069	0.009	0
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
0.035	-0.021	0.039	0.026	-0.015	.123**	.156**	0.062	0.056	0.066	.114*	0.058	0.057	.127**	0.077
0.444	0.64	0.395	0.571	0.743	0.007	0.001	0.171	0.223	0.15	0.012	0.205	0.213	0.005	0.09

483	483	482	482	483	483	483	483	483	483	483	483	482	483	483
0.042	-0.024	0.06	0.008	.108*	.093*	0.081	-0.042	0.084	0.005	.126**	0.037	0.043	.179**	.124**
0.358	0.594	0.185	0.857	0.018	0.041	0.074	0.351	0.064	0.912	0.005	0.419	0.35	0	0.006
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
.112*	0.023	.123**	.124**	0.086	.090*	0.045	-0.016	.152**	.120**	.104*	0.069	0.008	0.056	.103*
0.013	0.613	0.007	0.006	0.059	0.048	0.321	0.719	0.001	0.008	0.023	0.129	0.86	0.222	0.024
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
0.029	0.021	0.052	0.078	0.039	0.079	-0.001	.162**	0.042	0.022	.112*	0.022	.103*	0.068	0.027
0.522	0.651	0.258	0.087	0.397	0.082	0.983	0	0.358	0.63	0.013	0.633	0.024	0.134	0.558
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
0	0.035	0.02	-0.043	0.076	-0.042	0.023	0.029	.107*	.138**	0.04	.139**	0.082	0.048	.175**
0.997	0.448	0.655	0.344	0.094	0.359	0.619	0.527	0.019	0.002	0.378	0.002	0.071	0.287	0
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
0.06	0.064	0.084	0.036	-0.025	0.07	0.073	0.038	0.06	-0.018	0.049	0.04	-0.047	0.017	0.009
0.189	0.158	0.066	0.434	0.581	0.124	0.11	0.404	0.19	0.695	0.278	0.384	0.3	0.707	0.845
484	484	483	483	484	484	484	484	484	484	484	484	483	484	484
0.016	-0.002	-0.018	-.097*	-0.03	-0.06	0.015	-0.065	-0.042	0.014	-0.059	-0.038	-0.063	-0.026	-0.037
0.731	0.957	0.692	0.034	0.508	0.188	0.75	0.157	0.353	0.767	0.197	0.402	0.167	0.563	0.416
483	483	482	482	482	482	482	482	482	482	482	482	481	482	482
-0.047	0.022	-0.01	-.124**	0.033	-0.069	-0.003	0.006	0.06	0.017	-0.08	0.007	-0.006	-0.012	0.034
0.3	0.636	0.82	0.007	0.476	0.129	0.952	0.899	0.192	0.717	0.08	0.886	0.902	0.795	0.46
480	480	479	479	479	479	479	479	479	479	479	479	478	479	479
-0.027	-0.05	-0.021	0.036	0.004	0.066	0	-0.075	-0.045	-0.002	-0.075	-0.079	-0.074	-0.055	-.107*
0.555	0.275	0.639	0.426	0.928	0.146	0.992	0.099	0.325	0.968	0.099	0.083	0.105	0.231	0.019
482	482	481	481	481	481	481	481	481	481	481	481	480	481	481
0.062	0.053	0.001	0.007	0.051	0.078	0.089	0.013	-0.02	0.056	0.081	0.037	0.059	0.011	0.025
0.175	0.248	0.989	0.883	0.265	0.087	0.05	0.773	0.666	0.22	0.075	0.411	0.196	0.817	0.577
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
-0.041	-0.011	0.035	-0.003	0.019	-0.012	-0.05	0.017	-0.072	-0.051	0.015	-0.04	0.073	0.004	0.001
0.373	0.802	0.442	0.952	0.67	0.797	0.273	0.703	0.114	0.267	0.736	0.384	0.108	0.924	0.982
483	483	482	482	482	482	482	482	482	482	482	482	481	482	482
-0.023	0.009	-0.014	0.046	0.006	0.078	-0.033	0.07	0.01	0.055	.140**	0.043	.124**	0.033	0.019
0.608	0.841	0.753	0.316	0.891	0.087	0.471	0.126	0.827	0.224	0.002	0.351	0.006	0.468	0.678
484	484	483	483	483	483	483	483	483	483	483	483	482	483	483
-0.013	0.047	-0.017	-0.042	-0.024	-0.048	0.038	-0.064	0.025	-0.022	-.098*	0.009	-.113*	0.014	-0.054
0.775	0.301	0.709	0.351	0.593	0.296	0.41	0.161	0.587	0.625	0.031	0.845	0.013	0.766	0.237
484	484	483	483	483	483	483	483	483	483	483	483	482	483	483
0.033	-0.055	0.004	0.043	0.055	-0.027	-0.01	0.008	-0.001	0.083	0.042	0.077	0.071	0.028	0.07
0.473	0.233	0.926	0.358	0.24	0.567	0.836	0.863	0.98	0.073	0.368	0.096	0.129	0.547	0.131
466	466	465	465	465	465	465	465	465	465	465	465	464	465	465
-0.029	-0.026	0.011	0.038	0.016	0.015	0.026	0.044	-0.016	.096*	0.025	0.031	0.027	0.032	0.052
0.52	0.575	0.81	0.407	0.72	0.739	0.575	0.338	0.728	0.035	0.587	0.494	0.55	0.478	0.253
483	483	482	482	482	482	482	482	482	482	482	482	481	482	482
-0.037	-0.031	0.075	-0.048	.096*	-0.003	-0.001	-0.026	0.051	0.004	-0.038	0.029	0.001	0.028	0.083
0.419	0.499	0.1	0.297	0.035	0.954	0.991	0.569	0.264	0.929	0.402	0.519	0.989	0.542	0.07
482	482	481	481	481	481	481	481	481	481	481	481	480	481	481
0.038	0.059	0.006	0.035	0.029	.100*	.099*	.104*	.129**	0.066	.090*	0.03	0.015	.112*	0.072
0.406	0.192	0.901	0.437	0.521	0.029	0.029	0.022	0.004	0.145	0.048	0.51	0.735	0.014	0.113
483	483	482	482	482	482	482	482	482	482	482	482	481	482	482
.254**	0.078	.493**	.124**	.421**	.119**	.213**	.106*	.532**	.597**	.250**	.703**	.228**	.596**	.707**
0	0.088	0	0.007	0	0.009	0	0.02	0	0	0	0	0	0	0
481	481	481	480	481	481	481	481	481	481	481	481	480	481	481
.449**	.521**	.094*	.619**	-0.014	.581**	.499**	.579**	.175**	.274**	.598**	.178**	.439**	.175**	.133**
0	0	0.039	0	0.761	0	0	0	0	0	0	0	0	0	0.003
481	481	480	481	481	481	481	481	481	481	481	481	481	481	481
-0.008	-0.065	0.009	0.039	0.065	0.044	-0.063	-0.049	0.028	0.017	-0.051	0.048	0.042	0.017	0
0.857	0.157	0.842	0.391	0.156	0.339	0.169	0.281	0.537	0.705	0.267	0.293	0.354	0.716	0.996
483	483	482	482	482	482	482	482	482	482	482	482	481	482	482
-0.089	-0.018	0.018	-.110*	0.017	-.106*	-0.003	-0.053	0.054	0.04	-0.009	0.012	-0.081	-0.02	-0.018
0.051	0.697	0.687	0.016	0.701	0.019	0.951	0.241	0.235	0.385	0.851	0.787	0.075	0.667	0.69
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
.089*	0.085	-0.024	.131**	-0.059	0.088	0.037	0.084	0.031	.091*	0.018	0.077	0.082	0.047	0.019
0.049	0.062	0.595	0.004	0.198	0.054	0.419	0.065	0.498	0.045	0.695	0.092	0.07	0.301	0.684
485	485	484	484	484	484	484	484	484	484	484	484	483	484	484
-0.063	-.117*	0.051	-.164**	-0.011	-.184**	-0.022	-.187**	.092*	.112*	-.104*	.170**	-.146**	0.059	.193**
0.165	0.01	0.265	0	0.803	0	0.634	0	0.043	0.014	0.022	0	0.001	0.199	0
484	484	483	483	483	483	483	483	483	483	483	483	482	483	483
-0.095	-0.158	0.017	-0.089	0.051	-0.048	-0.101	-0.038	0.022	0.012	-0.012	0.131	-0.074	-.170*	0.085
0.242	0.051	0.835	0.274	0.535	0.557	0.216	0.639	0.789	0.887	0.88	0.109	0.367	0.036	0.297
153	153	153	153	152	152	152	152	152	152	152	152	152	152	152
-0.04	-0.013	0.037	0.064	-0.011	0.064	-0.001	0.076	0.025	-0.014	0.048	0.031	0.065	0.044	0.028
0.375	0.775	0.422	0.158	0.815	0.159	0.984	0.094	0.584	0.759	0.293	0.501	0.153	0.333	0.545
483	483	482	482	482	482	482	482	482	482	482	482	481	482	482
0.05	0.036	-0.04	0.029	0.058	-0.029	-0.013	-0.032	0.017	0.002	0.012	-0.002	-0.026	-0.042	0.008
0.27	0.424	0.383	0.525	0.2	0.523	0.779	0.487	0.711	0.963	0.791	0.957	0.574	0.363	0.857
483	483	482	482	482	482	482	482	482	482	482	482	481	482	482
-0.018	-0.052	0.011	-0.084	-0.03	-0.016	-0.009	-0.061	-0.034	0.019	-0.082	-0.01	-0.022	0.008	-0.038
0.685	0.25	0.81	0.066	0.506	0.724	0.849	0.179	0.458	0.684	0.071	0.821	0.637	0.861	0.411
483	483	482	482	482	482	482	482	482	482	482	482	481	482	482

formulameth	storytellingm	demonstratio	groupmetho	easy30	easyforsome	terriblemath	thisgrade33	lastmathclas	mathgrade3	mathrepeate	mathcompar	mathhighsco	mathlowscor	qualgrade41
-0.012	-0.028	0.023	-0.035	-0.012	0.017	.098*	.102*	0.078	-0.083	-0.01	-0.026	-0.08	.096*	-.096*
0.786	0.533	0.607	0.441	0.794	0.704	0.032	0.026	0.088	0.068	0.834	0.575	0.08	0.035	0.038
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
.160**	-0.049	0.011	-0.027	-.119**	0.028	0.063	0.047	0.038	0.001	0.015	-.093*	-.219**	.142**	0
0	0.286	0.808	0.553	0.009	0.543	0.169	0.302	0.402	0.991	0.748	0.041	0	0.002	0.998
483	482	483	483	483	483	483	482	479	481	484	482	483	483	465
-0.005	-0.015	0.043	-0.026	0.008	0.016	-0.019	0.008	-0.063	-0.012	.095*	-0.008	0.043	-0.031	0.048
0.908	0.742	0.344	0.568	0.868	0.72	0.673	0.86	0.169	0.794	0.037	0.865	0.343	0.497	0.306
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
0.022	-0.079	-0.058	-0.036	0.078	-0.053	-.131**	0.084	-0.04	0.019	-0.013	0.016	0.066	0.061	-0.058
0.633	0.083	0.206	0.424	0.086	0.24	0.004	0.065	0.379	0.672	0.774	0.722	0.149	0.179	0.212
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
-0.049	0.022	0.058	.091*	-0.067	0.057	0.011	.117*	-0.042	-0.011	0.008	-0.088	0.018	0.028	0
0.278	0.631	0.202	0.044	0.143	0.208	0.816	0.01	0.36	0.81	0.863	0.053	0.7	0.539	0.992
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
0.033	-0.059	0.016	0.001	-0.054	.105*	0.033	-0.029	0.018	-.121**	-0.065	-0.026	-.111*	0.056	0.027
0.469	0.196	0.724	0.975	0.238	0.021	0.467	0.521	0.701	0.008	0.152	0.568	0.015	0.219	0.564
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
-0.018	0.02	-0.022	0.04	0.044	-0.054	0.038	-0.088	0.025	-0.016	0.077	0.014	0.079	-0.041	0.02
0.693	0.66	0.624	0.374	0.333	0.234	0.398	0.053	0.583	0.725	0.091	0.753	0.083	0.369	0.669
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
-0.026	0.004	-0.032	0.07	0.004	-0.042	0.008	-0.002	-0.001	-0.015	-0.009	-0.049	0.036	-0.049	-0.003
0.569	0.924	0.48	0.123	0.926	0.36	0.867	0.965	0.978	0.742	0.848	0.28	0.431	0.281	0.947
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
-0.022	0.051	0.01	0.075	-0.015	0.005	-0.012	-0.018	-0.023	0.026	-0.069	-0.001	.112*	-0.081	0.005
0.625	0.261	0.821	0.1	0.746	0.918	0.8	0.689	0.617	0.567	0.131	0.977	0.014	0.074	0.921
483	482	483	483	483	483	483	482	479	481	484	482	483	483	465
0.026	.124**	0.062	0.05	0.033	.115*	0.041	-0.047	0.029	0.027	0.03	-0.02	0.067	-0.035	0.036
0.574	0.006	0.176	0.269	0.464	0.011	0.37	0.298	0.523	0.554	0.506	0.663	0.141	0.442	0.432
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
0.081	0.083	.122**	.112*	-0.037	.095*	-0.006	0.042	-0.035	-0.019	-0.023	-0.047	0.071	-0.002	0.018
0.075	0.067	0.008	0.014	0.419	0.036	0.901	0.36	0.443	0.672	0.611	0.308	0.12	0.972	0.702
482	481	482	482	482	482	482	481	478	480	483	481	482	482	464
.114*	0.035	0.042	.112*	0.029	0	0.06	0.016	-0.047	-0.027	0.062	-0.041	-0.023	-0.013	0.033
0.012	0.444	0.358	0.013	0.522	0.997	0.189	0.731	0.3	0.555	0.175	0.373	0.608	0.775	0.473
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
0.062	-0.021	-0.024	0.023	0.021	0.035	0.064	-0.002	0.022	-0.05	0.053	-0.011	0.009	0.047	-0.055
0.176	0.64	0.594	0.613	0.651	0.448	0.158	0.957	0.636	0.275	0.248	0.802	0.841	0.301	0.233
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
0.076	0.039	0.06	.123**	0.052	0.02	0.084	-0.018	-0.01	-0.021	0.001	0.035	-0.014	-0.017	0.004
0.094	0.395	0.185	0.007	0.258	0.655	0.066	0.692	0.82	0.639	0.989	0.442	0.753	0.709	0.926
483	482	483	483	483	483	483	482	479	481	484	482	483	483	465
0.067	0.026	0.008	.124**	0.078	-0.043	0.036	-.097*	-.124**	0.036	0.007	-0.003	0.046	-0.042	0.043
0.144	0.571	0.857	0.006	0.087	0.344	0.434	0.034	0.007	0.426	0.883	0.952	0.316	0.351	0.358
483	482	483	483	483	483	483	482	479	481	484	482	483	483	465
.096*	-0.015	.108*	0.086	0.039	0.076	-0.025	-0.03	0.033	0.004	0.051	0.019	0.006	-0.024	0.055
0.035	0.743	0.018	0.059	0.397	0.094	0.581	0.508	0.476	0.928	0.265	0.67	0.891	0.593	0.24
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
-0.02	.123**	.093*	.090*	0.079	-0.042	0.07	-0.06	-0.069	0.066	0.078	-0.012	0.078	-0.048	-0.027
0.665	0.007	0.041	0.048	0.082	0.359	0.124	0.188	0.129	0.146	0.087	0.797	0.087	0.296	0.567
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
0.048	.156**	0.081	0.045	-0.001	0.023	0.073	0.015	-0.003	0	0.089	-0.05	-0.033	0.038	-0.01
0.295	0.001	0.074	0.321	0.983	0.619	0.11	0.75	0.952	0.992	0.05	0.273	0.471	0.41	0.836
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
0.079	0.062	-0.042	-0.016	.162**	0.029	0.038	-0.065	0.006	-0.075	0.013	0.017	0.07	-0.064	0.008
0.083	0.171	0.351	0.719	0	0.527	0.404	0.157	0.899	0.099	0.773	0.703	0.126	0.161	0.863
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
0.087	0.056	0.084	.152**	0.042	.107*	0.06	-0.042	0.06	-0.045	-0.02	-0.072	0.01	0.025	-0.001
0.055	0.223	0.064	0.001	0.358	0.019	0.19	0.353	0.192	0.325	0.666	0.114	0.827	0.587	0.98
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
.142**	0.066	0.005	.120**	0.022	.138**	-0.018	0.014	0.017	-0.002	0.056	-0.051	0.055	-0.022	0.083
0.002	0.15	0.912	0.008	0.63	0.002	0.695	0.767	0.717	0.968	0.22	0.267	0.224	0.625	0.073
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
0.009	.114*	.126**	.104*	.112*	0.04	0.049	-0.059	-0.08	-0.075	0.081	0.015	.140**	-.098*	0.042
0.844	0.012	0.005	0.023	0.013	0.378	0.278	0.197	0.08	0.099	0.075	0.736	0.002	0.031	0.368
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
.181**	0.058	0.037	0.069	0.022	.139**	0.04	-0.038	0.007	-0.079	0.037	-0.04	0.043	0.009	0.077
0	0.205	0.419	0.129	0.633	0.002	0.384	0.402	0.886	0.083	0.411	0.384	0.351	0.845	0.096
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
0.083	0.057	0.043	0.008	.103*	0.082	-0.047	-0.063	-0.006	-0.074	0.059	0.073	.124**	-.113*	0.071
0.069	0.213	0.35	0.86	0.024	0.071	0.3	0.167	0.902	0.105	0.196	0.108	0.006	0.013	0.129
483	482	483	483	483	483	483	481	478	480	483	481	482	482	464
.119**	.127**	.179**	0.056	0.068	0.048	0.017	-0.026	-0.012	-0.055	0.011	0.004	0.033	0.014	0.028
0.009	0.005	0	0.222	0.134	0.287	0.707	0.563	0.795	0.231	0.817	0.924	0.468	0.766	0.547
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
.218**	0.077	.124**	.103*	0.027	.175**	0.009	-0.037	0.034	-.107*	0.025	0.001	0.019	-0.054	0.07
0	0.09	0.006	0.024	0.558	0	0.845	0.416	0.46	0.019	0.577	0.982	0.678	0.237	0.131
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
1	-0.078	-0.024	-0.059	0.082	.173**	0.012	0.022	0.042	-0.056	-0.04	0.07	-.142**	0.066	0
.	0.088	0.601	0.193	0.07	0	0.786	0.624	0.365	0.219	0.375	0.125	0.002	0.149	1
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
-0.078	1	.340**	-0.018	0.051	-0.023	.107*	-0.066	-0.064	0.016	0.007	-0.038	0.025	-0.014	0.04
0.088	.	0	0.701	0.262	0.613	0.018	0.146	0.161	0.723	0.874	0.405	0.584	0.765	0.388

483	483	483	483	483	483	483	481	478	480	483	481	482	482	464
-0.024	.340**	1	.154**	0.031	-0.007	0.074	-0.018	-0.033	0.063	0.002	-0.026	0.038	0.017	-0.044
0.601	0	.	0.001	0.502	0.879	0.103	0.698	0.468	0.165	0.957	0.573	0.41	0.705	0.342
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
-0.059	-0.018	.154**	1	0.007	-0.048	0.043	0.084	0.014	0.085	0.025	-.101*	-0.065	0.076	-0.065
0.193	0.701	0.001	.	0.883	0.295	0.346	0.066	0.764	0.063	0.576	0.026	0.151	0.097	0.161
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
0.082	0.051	0.031	0.007	1	0.039	0.02	-.469**	-.103*	-.176**	-.090*	.496**	.242**	-.287**	0.038
0.07	0.262	0.502	0.883	.	0.388	0.655	0	0.024	0	0.049	0	0	0	0.409
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
.173**	-0.023	-0.007	-0.048	0.039	1	-0.035	0.007	.119**	-0.083	0.06	0.013	-0.046	0.049	0.018
0	0.613	0.879	0.295	0.388	.	0.44	0.87	0.009	0.07	0.191	0.769	0.316	0.281	0.695
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
0.012	.107*	0.074	0.043	0.02	-0.035	1	-0.053	-0.017	-0.005	0.035	0.009	-0.073	0.053	0.06
0.786	0.018	0.103	0.346	0.655	0.44	.	0.244	0.711	0.915	0.44	0.835	0.109	0.243	0.195
484	483	484	484	484	484	484	482	479	481	484	482	483	483	465
0.022	-0.066	-0.018	0.084	-.469**	0.007	-0.053	1	0.088	.229**	.096*	-.463**	-.275**	.365**	-.122**
0.624	0.146	0.698	0.066	0	0.87	0.244	.	0.054	0	0.035	0	0	0	0.008
482	481	482	482	482	482	482	483	478	480	483	481	482	482	464
0.042	-0.064	-0.033	0.014	-.103*	.119**	-0.017	0.088	1	-.156**	-0.023	-0.054	-0.06	.090*	-.124**
0.365	0.161	0.468	0.764	0.024	0.009	0.711	0.054	.	0.001	0.617	0.243	0.192	0.049	0.007
479	478	479	479	479	479	479	478	480	478	480	478	479	479	461
-0.056	0.016	0.063	0.085	-.176**	-0.083	-0.005	.229**	-.156**	1	0.065	-.094*	-.093*	0.078	-.233**
0.219	0.723	0.165	0.063	0	0.07	0.915	0	0.001	.	0.155	0.039	0.041	0.087	0
481	480	481	481	481	481	481	480	478	482	482	480	481	481	463
-0.04	0.007	0.002	0.025	-.090*	0.06	0.035	.096*	-0.023	0.065	1	-0.039	-0.019	0.041	-0.003
0.375	0.874	0.957	0.576	0.049	0.191	0.44	0.035	0.617	0.155	.	0.389	0.674	0.365	0.951
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
0.07	-0.038	-0.026	-.101*	.496**	0.013	0.009	-.463**	-0.054	-.094*	-0.039	1	.221**	-.248**	0.086
0.125	0.405	0.573	0.026	0	0.769	0.835	0	0.243	0.039	0.389	.	0	0	0.065
482	481	482	482	482	482	482	481	478	480	483	483	482	482	464
-.142**	0.025	0.038	-0.065	.242**	-0.046	-0.073	-.275**	-0.06	-.093*	-0.019	.221**	1	.488**	0.086
0.002	0.584	0.41	0.151	0	0.316	0.109	0	0.192	0.041	0.674	0	.	0	0.065
483	482	483	483	483	483	483	482	479	481	484	482	484	483	466
0.066	-0.014	0.017	0.076	-.287**	0.049	0.053	.365**	.090*	0.078	0.041	-.248**	.488**	1	-.112*
0.149	0.765	0.705	0.097	0	0.281	0.243	0	0.049	0.087	0.365	0	0	.	0.015
483	482	483	483	483	483	483	482	479	481	484	482	483	484	465
0	0.04	-0.044	-0.065	0.038	0.018	0.06	-.122**	-.124**	-.233**	-0.003	0.086	0.086	-.112*	1
1	0.388	0.342	0.161	0.409	0.695	0.195	0.008	0.007	0	0.951	0.065	0.065	0.015	.
465	464	465	465	465	465	465	464	461	463	466	464	466	465	466
0.048	0.039	-0.083	-0.079	-0.029	0.005	-0.037	0.022	0.042	-0.024	-0.046	0.049	-0.019	-0.036	.419**
0.289	0.394	0.069	0.085	0.531	0.921	0.421	0.625	0.361	0.602	0.309	0.288	0.678	0.425	0
482	481	482	482	482	482	482	481	478	480	483	481	482	482	466
-0.063	-0.018	0.007	0.021	0.01	0.063	0.005	-0.03	0.06	0.012	-0.037	0.031	-0.026	-0.053	-0.048
0.166	0.7	0.873	0.641	0.827	0.167	0.916	0.514	0.193	0.8	0.413	0.496	0.572	0.248	0.306
481	480	481	481	481	481	481	480	477	479	482	480	481	481	465
0.022	-0.03	-0.029	0.019	0.009	.113*	0.042	0.048	0.011	-0.006	0.066	-0.033	0	-0.017	0.008
0.631	0.505	0.525	0.671	0.837	0.013	0.356	0.294	0.805	0.89	0.145	0.466	0.992	0.718	0.868
482	481	482	482	482	482	482	481	478	480	483	481	482	482	466
.135**	.139**	.154**	.141**	0.051	.128**	0.048	-0.054	0.013	-0.058	0.037	-0.029	0.068	-0.02	0.082
0.003	0.002	0.001	0.002	0.263	0.005	0.289	0.24	0.772	0.202	0.413	0.532	0.137	0.664	0.08
481	480	481	481	481	481	481	479	476	478	481	479	480	480	462
0.054	.097*	0.06	.095*	.107*	0.015	0.076	-0.066	-0.043	-0.042	0.078	-0.013	.096*	-0.053	0.021
0.236	0.035	0.19	0.038	0.018	0.744	0.095	0.148	0.351	0.356	0.086	0.768	0.035	0.245	0.648
481	480	481	481	481	481	481	479	476	478	481	479	480	480	462
-0.047	-0.016	0.034	0.038	.164**	-0.083	0.08	-.310**	-0.027	-0.051	-0.077	.198**	.095*	-.102*	0.01
0.304	0.732	0.453	0.401	0	0.07	0.079	0	0.555	0.263	0.092	0	0.036	0.025	0.834
482	481	482	482	482	482	482	483	478	480	483	481	482	482	464
-0.012	-0.024	0.015	-0.034	-0.016	0.014	.098*	.095*	0.055	-0.08	-0.008	-0.022	-0.073	.104*	-0.083
0.785	0.593	0.749	0.45	0.725	0.761	0.031	0.038	0.227	0.078	0.865	0.635	0.107	0.021	0.074
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
-0.007	0.065	0.024	0.013	0.048	-0.056	-0.086	-0.044	-.309**	0.006	0.048	0.022	.095*	-0.076	.207**
0.874	0.151	0.596	0.78	0.291	0.217	0.059	0.338	0	0.893	0.292	0.636	0.037	0.093	0
484	483	484	484	484	484	484	483	480	482	485	483	484	484	466
.160**	-0.049	0.011	-0.027	-.119**	0.028	0.063	0.047	0.038	0.001	0.015	-.093*	-.219**	.142**	0
0	0.286	0.808	0.553	0.009	0.543	0.169	0.302	0.402	0.991	0.748	0.041	0	0.002	0.998
483	482	483	483	483	483	483	482	479	481	484	482	483	483	465
-0.005	-0.012	-0.109	-.177*	.501**	-0.091	0.096	-.947**	-0.039	-.181*	-.177*	.509**	.326**	.520**	0.106
0.951	0.879	0.18	0.029	0	0.265	0.24	0	0.633	0.025	0.029	0	0	0	0.198
152	152	152	152	152	152	152	153	153	152	153	153	153	153	149
-0.045	0.054	-0.032	-0.061	.345**	0.004	-0.009	-.828**	-.129**	-.235**	-0.062	.339**	.290**	.341**	.121**
0.328	0.241	0.485	0.184	0	0.922	0.85	0	0.005	0	0.174	0	0	0	0.009
482	481	482	482	482	482	482	483	478	480	483	481	482	482	464
0.053	0.008	0.082	-0.026	0.084	-0.008	0.089	-0.017	.102*	0.076	-0.027	0.082	-.111*	0.064	-0.029
0.242	0.857	0.074	0.567	0.065	0.863	0.051	0.716	0.026	0.095	0.554	0.074	0.015	0.16	0.529
482	481	482	482	482	482	482	483	478	480	483	481	482	482	464
-0.033	-0.07	-0.046	.106*	-.386**	-0.027	-0.061	.747**	0.007	.135**	0.064	-.364**	-.135**	.238**	-0.087
0.475	0.124	0.31	0.02	0	0.55	0.182	0	0.886	0.003	0.157	0	0.003	0	0.062
482	481	482	482	482	482	482	483	478	480	483	481	482	482	464

qualcourse41	qualgender4	qualgendiff4	Connected K	Seperate Kno	Student Ache	Class Type	class name	Gender Reco	thisgrade33.	A_Grade	B_Grade	C_Grade
-0.05	0.062	-0.074	0.022	-.093*	-0.042	.976**	-.310**	.202**	-0.119	-.098*	0.026	0.055
0.272	0.178	0.106	0.631	0.042	0.351	0	0	0	0.143	0.031	0.57	0.228
483	482	483	481	481	483	486	486	484	153	483	483	483
-0.039	0.067	0.018	.170**	-.216**	-0.086	.197**	-.139**	1.000**	0.084	-0.042	0.015	-0.007
0.398	0.142	0.698	0	0	0.059	0	0.002	.	0.303	0.357	0.745	0.884
482	481	482	480	480	482	484	484	484	153	482	482	482
-.110*	0.008	-0.025	0.012	0.009	0.026	-0.016	.135**	-0.085	-0.049	-0.015	0.011	0.013
0.016	0.866	0.58	0.792	0.837	0.574	0.719	0.003	0.063	0.546	0.75	0.816	0.781
483	482	483	481	481	483	485	485	484	153	483	483	483
-0.008	-0.058	0.039	0.006	0.046	-0.008	-0.081	-0.014	-0.073	-.176*	-.095*	0.042	0.047
0.866	0.202	0.39	0.9	0.315	0.865	0.073	0.755	0.108	0.029	0.038	0.359	0.308
483	482	483	481	481	483	485	485	484	153	483	483	483
-0.075	0.063	.189**	.105*	0.068	-0.077	0.017	0.035	0.021	-0.107	-0.031	-.116*	.133**
0.101	0.168	0	0.021	0.138	0.091	0.712	0.444	0.651	0.187	0.494	0.011	0.003
483	482	483	481	481	483	485	485	484	153	483	483	483
-0.014	0.01	0.043	0.045	-.126**	-0.071	.135**	-0.058	.243**	0.053	0.063	-0.059	-0.025
0.756	0.824	0.35	0.322	0.006	0.117	0.003	0.201	0	0.512	0.17	0.195	0.59
483	482	483	481	481	483	485	485	484	153	483	483	483
0.034	0.022	-0.03	.510**	.209**	.113*	-0.013	0.006	0.032	.183*	0.084	-0.031	-0.008
0.455	0.632	0.516	0	0	0.013	0.779	0.9	0.485	0.024	0.066	0.501	0.867
483	482	483	481	481	483	485	485	484	153	483	483	483
-0.029	-.101*	0.084	0.019	.523**	0.02	-0.056	0.056	-.141**	-0.084	-0.001	0.003	0.006
0.522	0.026	0.066	0.671	0	0.667	0.222	0.219	0.002	0.303	0.978	0.955	0.898
483	482	483	481	481	483	485	485	484	153	483	483	483
-0.004	-0.006	0.028	.148**	.317**	-0.018	0.002	0.018	-0.053	0.068	0.009	0.016	-0.033
0.923	0.887	0.534	0.001	0	0.701	0.959	0.69	0.248	0.405	0.849	0.733	0.468
482	481	482	480	481	482	484	484	483	152	482	482	482
-0.013	0.033	0.062	.466**	.152**	0.015	-0.045	0.066	.123**	-0.028	0.047	-0.013	-0.027
0.777	0.476	0.173	0	0.001	0.735	0.326	0.149	0.007	0.733	0.304	0.777	0.548
483	482	483	481	481	483	485	485	484	153	483	483	483
0.002	0.025	0.005	.588**	.166**	0.024	0.04	-0.019	0.086	-0.019	-0.008	-0.054	0.079
0.966	0.578	0.912	0	0	0.602	0.375	0.678	0.059	0.814	0.854	0.238	0.085
481	480	481	481	479	481	483	483	482	153	481	481	481
-0.029	-0.037	0.038	.254**	.449**	-0.008	-0.089	.089*	-0.063	-0.095	-0.04	0.05	-0.018
0.52	0.419	0.406	0	0	0.857	0.051	0.049	0.165	0.242	0.375	0.27	0.685
483	482	483	481	481	483	485	485	484	153	483	483	483
-0.026	-0.031	0.059	0.078	.521**	-0.065	-0.018	0.085	-.117*	-0.158	-0.013	0.036	-0.052
0.575	0.499	0.192	0.088	0	0.157	0.697	0.062	0.01	0.051	0.775	0.424	0.25
483	482	483	481	481	483	485	485	484	153	483	483	483
0.011	0.075	0.006	.499**	.094*	0.009	0.018	-0.024	0.051	0.017	0.037	-0.04	0.011
0.81	0.1	0.901	0	0.039	0.842	0.687	0.595	0.265	0.835	0.422	0.383	0.81
482	481	482	481	480	482	484	484	483	153	482	482	482
0.038	-0.048	0.035	.124**	.619**	0.039	-.110*	.131**	-.164**	-0.089	0.064	0.029	-0.084
0.407	0.297	0.437	0.007	0	0.391	0.016	0.004	0	0.274	0.158	0.525	0.066
482	481	482	480	481	482	484	484	483	153	482	482	482
0.016	.096*	0.029	.421**	-0.014	0.065	0.017	-0.059	-0.011	0.051	-0.011	0.058	-0.03
0.72	0.035	0.521	0	0.761	0.156	0.701	0.198	0.803	0.535	0.815	0.2	0.506
482	481	482	481	481	482	484	484	483	152	482	482	482
0.015	-0.003	.100*	.119**	.581**	0.044	-.106*	0.088	-.184**	-0.048	0.064	-0.029	-0.016
0.739	0.954	0.029	0.009	0	0.339	0.019	0.054	0	0.557	0.159	0.523	0.724
482	481	482	481	481	482	484	484	483	152	482	482	482
0.026	-0.001	.099*	.213**	.499**	-0.063	-0.003	0.037	-0.022	-0.101	-0.001	-0.013	-0.009
0.575	0.991	0.029	0	0	0.169	0.951	0.419	0.634	0.216	0.984	0.779	0.849
482	481	482	481	481	482	484	484	483	152	482	482	482
0.044	-0.026	.104*	.106*	.579**	-0.049	-0.053	0.084	-.187**	-0.038	0.076	-0.032	-0.061
0.338	0.569	0.022	0.02	0	0.281	0.241	0.065	0	0.639	0.094	0.487	0.179
482	481	482	481	481	482	484	484	483	152	482	482	482
-0.016	0.051	.129**	.537**	.175**	0.028	0.054	0.031	.092*	0.022	0.025	0.017	-0.034
0.728	0.264	0.004	0	0	0.537	0.235	0.498	0.043	0.789	0.584	0.711	0.458
482	481	482	481	481	482	484	484	483	152	482	482	482
.096*	0.004	0.066	.597**	.274**	0.017	0.04	.091*	.112*	0.012	-0.014	0.002	0.019
0.035	0.929	0.145	0	0	0.705	0.385	0.045	0.014	0.887	0.759	0.963	0.684
482	481	482	481	481	482	484	484	483	152	482	482	482
0.025	-0.038	.090*	.250**	.598**	-0.051	-0.009	0.018	-.104*	-0.012	0.048	0.012	-0.082
0.587	0.402	0.048	0	0	0.267	0.851	0.695	0.022	0.88	0.293	0.791	0.071
482	481	482	481	481	482	484	484	483	152	482	482	482
0.031	0.029	0.03	.703**	.178**	0.048	0.012	0.077	.170**	0.131	0.031	-0.002	-0.01
0.494	0.519	0.51	0	0	0.293	0.787	0.092	0	0.109	0.501	0.957	0.821
482	481	482	481	481	482	484	484	483	152	482	482	482
0.027	0.001	0.015	.228**	.439**	0.042	-0.081	0.082	-.146**	-0.074	0.065	-0.026	-0.022
0.55	0.989	0.735	0	0	0.354	0.075	0.07	0.001	0.367	0.153	0.574	0.637
481	480	481	480	481	481	483	483	482	152	481	481	481
0.032	0.028	.112*	.596**	.175**	0.017	-0.02	0.047	0.059	-.170*	0.044	-0.042	0.008
0.478	0.542	0.014	0	0	0.716	0.667	0.301	0.199	0.036	0.333	0.363	0.861
482	481	482	481	481	482	484	484	483	152	482	482	482
0.052	0.083	0.072	.707**	.133**	0	-0.018	0.019	.193**	0.085	0.028	0.008	-0.038
0.253	0.07	0.113	0	0.003	0.996	0.69	0.684	0	0.297	0.545	0.857	0.411
482	481	482	481	481	482	484	484	483	152	482	482	482
0.048	-0.063	0.022	.135**	0.054	-0.047	-0.012	-0.007	.160**	-0.005	-0.045	0.053	-0.033
0.289	0.166	0.631	0.003	0.236	0.304	0.785	0.874	0	0.951	0.328	0.242	0.475
482	481	482	481	481	482	484	484	483	152	482	482	482
0.039	-0.018	-0.03	.139**	.097*	-0.016	-0.024	0.065	-0.049	-0.012	0.054	0.008	-0.07
0.394	0.7	0.505	0.002	0.035	0.732	0.593	0.151	0.286	0.879	0.241	0.857	0.124

481	480	481	480	480	481	483	483	482	152	481	481	481
-0.083	0.007	-0.029	.154**	0.06	0.034	0.015	0.024	0.011	-0.109	-0.032	0.082	-0.046
0.069	0.873	0.525	0.001	0.19	0.453	0.749	0.596	0.808	0.18	0.485	0.074	0.31
482	481	482	481	481	482	484	484	483	152	482	482	482
-0.079	0.021	0.019	.141**	.095*	0.038	-0.034	0.013	-0.027	-.177*	-0.061	-0.026	.106*
0.085	0.641	0.671	0.002	0.038	0.401	0.45	0.78	0.553	0.029	0.184	0.567	0.02
482	481	482	481	481	482	484	484	483	152	482	482	482
-0.029	0.01	0.009	0.051	.107*	.164**	-0.016	0.048	-.119**	.501**	.345**	0.084	-.386**
0.531	0.827	0.837	0.263	0.018	0	0.725	0.291	0.009	0	0	0.065	0
482	481	482	481	481	482	484	484	483	152	482	482	482
0.005	0.063	.113*	.128**	0.015	-0.083	0.014	-0.056	0.028	-0.091	0.004	-0.008	-0.027
0.921	0.167	0.013	0.005	0.744	0.07	0.761	0.217	0.543	0.265	0.922	0.863	0.55
482	481	482	481	481	482	484	484	483	152	482	482	482
-0.037	0.005	0.042	0.048	0.076	0.08	.098*	-0.086	0.063	0.096	-0.009	0.089	-0.061
0.421	0.916	0.356	0.289	0.095	0.079	0.031	0.059	0.169	0.24	0.85	0.051	0.182
482	481	482	481	481	482	484	484	483	152	482	482	482
0.022	-0.03	0.048	-0.054	-0.066	-.310**	.095*	-0.044	0.047	.947**	-.828**	-0.017	.747**
0.625	0.514	0.294	0.24	0.148	0	0.038	0.338	0.302	0	0	0.716	0
481	480	481	479	479	483	483	483	482	153	483	483	483
0.042	0.06	0.011	0.013	-0.043	-0.027	0.055	-.309**	0.038	-0.039	-.129**	.102*	0.007
0.361	0.193	0.805	0.772	0.351	0.555	0.227	0	0.402	0.633	0.005	0.026	0.886
478	477	478	476	476	478	480	480	479	153	478	478	478
-0.024	0.012	-0.006	-0.058	-0.042	-0.051	-0.08	0.006	0.001	-.181*	-.235**	0.076	.135**
0.602	0.8	0.89	0.202	0.356	0.263	0.078	0.893	0.991	0.025	0	0.095	0.003
480	479	480	478	478	480	482	482	481	152	480	480	480
-0.046	-0.037	0.066	0.037	0.078	-0.077	-0.008	0.048	0.015	-.177*	-0.062	-0.027	0.064
0.309	0.413	0.145	0.413	0.086	0.092	0.865	0.292	0.748	0.029	0.174	0.554	0.157
483	482	483	481	481	483	485	485	484	153	483	483	483
0.049	0.031	-0.033	-0.029	-0.013	.198**	-0.022	0.022	-.093*	.509**	.339**	0.082	-.364**
0.288	0.496	0.466	0.532	0.768	0	0.635	0.636	0.041	0	0	0.074	0
481	480	481	479	479	481	483	483	482	153	481	481	481
-0.019	-0.026	0	0.068	.096*	.095*	-0.073	.095*	-.219**	.326**	.290**	-.111*	-.135**
0.678	0.572	0.992	0.137	0.035	0.036	0.107	0.037	0	0	0	0.015	0.003
482	481	482	480	480	482	484	484	483	153	482	482	482
-0.036	-0.053	-0.017	-0.02	-0.053	-.102*	.104*	-0.076	.142**	-.520**	.341**	0.064	.238**
0.425	0.248	0.718	0.664	0.245	0.025	0.021	0.093	0.002	0	0	0.16	0
482	481	482	480	480	482	484	484	483	153	482	482	482
.419**	-0.048	0.008	0.082	0.021	0.01	-0.083	.207**	0	0.106	.121**	-0.029	-0.087
0	0.306	0.868	0.08	0.648	0.834	0.074	0	0.998	0.198	0.009	0.529	0.062
466	465	466	462	462	464	466	466	465	149	464	464	464
1	-0.059	-0.028	0.054	0.034	-0.01	-0.031	0.042	-0.039	-0.026	-0.044	0.047	-0.011
.	0.195	0.535	0.239	0.464	0.835	0.491	0.354	0.398	0.75	0.334	0.305	0.806
483	482	483	479	479	481	483	483	482	153	481	481	481
-0.059	1	0.015	0.069	-0.075	0.004	0.053	0.008	0.067	0.13	0.001	0.045	-0.05
0.195	.	0.745	0.131	0.1	0.937	0.245	0.853	0.142	0.11	0.985	0.323	0.271
482	482	482	478	478	480	482	482	481	153	480	480	480
-0.028	0.015	1	0.082	.118**	0.033	-0.088	0.01	0.018	-0.054	0.013	-.104*	.117*
0.535	0.745	.	0.074	0.01	0.469	0.054	0.825	0.698	0.506	0.783	0.023	0.01
483	482	483	479	479	481	483	483	482	153	481	481	481
0.054	0.069	0.082	1	.260**	0.052	0.012	0.028	.170**	0.047	0.06	-0.033	-0.004
0.239	0.131	0.074	.	0	0.257	0.796	0.536	0	0.563	0.188	0.466	0.927
479	478	479	481	478	479	481	481	480	152	479	479	479
0.034	-0.075	.118**	.260**	1	-0.019	-0.081	.108*	-.216**	-0.114	0.053	0.009	-0.073
0.464	0.1	0.01	0	.	0.671	0.076	0.018	0	0.165	0.245	0.836	0.112
479	478	479	478	481	479	481	481	480	151	479	479	479
-0.01	0.004	0.033	0.052	-0.019	1	-0.041	-0.018	-0.086	.339**	.108*	.150**	.103*
0.835	0.937	0.469	0.257	0.671	.	0.371	0.693	0.059	0	0.018	0.001	0.024
481	480	481	479	479	483	483	483	482	153	483	483	483
-0.031	0.053	-0.088	0.012	-0.081	-0.041	1	-.318**	.197**	-0.107	-.096*	0.033	0.046
0.491	0.245	0.054	0.796	0.076	0.371	.	0	0	0.188	0.035	0.473	0.315
483	482	483	481	481	483	486	486	484	153	483	483	483
0.042	0.008	0.01	0.028	.108*	-0.018	-.318**	1	-.139**	-0.04	.101*	-.114*	0.019
0.354	0.853	0.825	0.536	0.018	0.693	0	.	0.002	0.622	0.026	0.012	0.678
483	482	483	481	481	483	486	486	484	153	483	483	483
-0.039	0.067	0.018	.170**	-.216**	-0.086	.197**	-.139**	1	0.084	-0.042	0.015	-0.007
0.398	0.142	0.698	0	0	0.059	0	0.002	.	0.303	0.357	0.745	0.884
482	481	482	480	480	482	484	484	484	153	482	482	482
-0.026	0.13	-0.054	0.047	-0.114	.339**	-0.107	-0.04	0.084	1	.774**	0.04	-.681**
0.75	0.11	0.506	0.563	0.165	0	0.188	0.622	0.303	.	0	0.623	0
153	153	153	152	151	153	153	153	153	153	153	153	153
-0.044	0.001	0.013	0.06	0.053	.108*	-.096*	.101*	-0.042	.774**	1	-.542**	-.370**
0.334	0.985	0.783	0.188	0.245	0.018	0.035	0.026	0.357	0	.	0	0
481	480	481	479	479	483	483	483	482	153	483	483	483
0.047	0.045	-.104*	-0.033	0.009	.150**	0.033	-.114*	0.015	0.04	-.542**	1	-.517**
0.305	0.323	0.023	0.466	0.836	0.001	0.473	0.012	0.745	0.623	0	.	0
481	480	481	479	479	483	483	483	482	153	483	483	483
-0.011	-0.05	.117*	-0.004	-0.073	.103*	0.046	0.019	-0.007	-.681**	-.370**	-.517**	1
0.806	0.271	0.01	0.927	0.112	0.024	0.315	0.678	0.884	0	0	0	.
481	480	481	479	479	483	483	483	482	153	483	483	483

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