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"At-Risk" Rural Middle-School Students' Perceptions of Problem-Based Learning in Mathematics

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"AT-RISK" RURAL MIDDLE-SCHOOL STUDENTS' PERCEPTIONS OF PROBLEM-BASED LEARNING IN MATHEMATICS

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(Under the Direction of Dan Rea)

ABSTRACT

Middle-grade students who fail math have at least a three-in-four chance of dropping out of high school (Neild & Balfanz, 2006). Furthermore, these students, especially female students, at risk of failure in mathematics and consequent dropout, may not be well served by traditional teaching methods because of their inequitable instructional practices (Lerner & Sadker, 1999). This case study of eight seventh-grade students from a rural school in Georgia sought to gain insight into whether PBL (problem-based learning) was perceived to be an effective teaching method for "at-risk" middle-school mathematics students and female students in particular. The goals of the study were to investigate and identify the thematic perceptions of "at-risk" seventh-grade students after their experience with PBL and determine gender influences on their perceptions. The results of the study revealed that PBL effectively met the perceived learning and motivational needs of the "at-risk" students and provided an equitable method of teaching for both the female and male students but for different reasons. Educational recommendations are provided to enhance further the implementation of PBL for "at-risk" mathematics students, especially female students.

INDEX WORDS: Problem-Based Learning, STEM, Students At Risk, Gender Differences

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by

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DEDICATION

This dissertation is dedicated to my family, my husband Don and my sons, Michael and Jordan, whom I love beyond words. I am grateful to have such a wonderful family. My husband Don was always there to keep me motivated and I would not have finished this program without him. Thank you for the unconditional love and support on this journey. When I began this journey, one of the primary reasons I did so was to set an example for my children. I hope it worked and I hope one day to celebrate their doctoral achievement. This dissertation is also dedicated to anyone who has ever struggled in mathematics. You can achieve your dreams if you refuse to give up.

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CHAPTER 1

INTRODUCTION

Students at risk of failure in mathematics during the early middle grades are probable candidates to subsequently suffer serious educational consequences. According to a study at Johns Hopkins University (Neild & Balfanz, 2006), middle grade students who failed math had at least a three-in-four chance of dropping out of high school. Middle-school students, especially female students, at risk of failure in mathematics and consequent dropout, may not be well served by traditional teaching methods (Lerner & Sadker, 1999). Furthermore, these traditional methods may contribute to the current gender gap in learning mathematics (Faller & Holden, 2015). Alternative methods of mathematics instruction need to be investigated to find a more reasonable and unbiased way to serve the learning needs of "at-risk" students, especially female students (Geist & King, 2008).

In regards to the gender gap, boys and girls show little difference in mathematics in the beginning; however, significant differences emerge during the first six years of schooling. Girls lose one-fourth of a standard deviation relative to boys over the first six years of school (Neiderle & Vesterlund, 2010). For females, this downward spiral in mathematics continues resulting in fewer females enrolled in higher-mathematics courses and ultimately an underrepresentation of females in STEM (Science, Technology, Engineering, and Mathematics) careers. Years of being unsuccessful in mathematics classes for both males and females take a heavy toll, and for some students, dropping out becomes their only option.

The high cost of dropping out of school is not limited to the almost eight-thousand-dollar difference in paychecks between graduates and dropouts (Snyder & Dillow, 2013). There is also a high cost to society. Diminished earning potential for high-school dropouts translates to lower local, state, and federal tax revenues. High-school graduates provide both social and economic benefits to society. Graduates are less likely to commit crimes, live on government assistance, become teen parents and are generally more civic-minded (Carneval, Smith, & Strohl, 2010).

The present case study examined how seventh-grade math students, especially female students at risk of failure, perceived changes in their learning and motivation (e.g., confidence and interest) after being involved with problem-based learning (PBL) in mathematics. Gender differences in learning and motivation, after using the PBL method, were explored to see if this alternative mathematics teaching method was perceived differently by "at-risk" male and female students; whether it could effectively build student motivation and learning and empower students considered at risk. PBL is a collaborative instructional method that is both interactional and student-centered (Bridges, 1992), and research has found that "at-risk" students benefit from instructional strategies that contain these learning elements (Lambros, 2002).

The use of gender-biased traditional teaching styles, considered by some to be individualistic and competitive, may be placing female students at risk because they are incompatible with the developmental needs of young females (Hoffmann & Haussler, 1998). Rather than developing problem-solving skills, traditional teaching methods rely on rote memorization giving students little opportunity to develop critical thinking skills. However, when students learn with understanding, they are able to transfer their knowledge to tasks that require problem solving with greater success than those who learn only by rote memorization (Barron & Darling-

Hammond, 2008). The Georgia Department of Education (GADOE) as well as the National

Council of Mathematics Teachers (NCTM) endorses experiential learning methods such as PBL

as a teaching method, which promotes hands-on curriculum and allows students to see the real

world application of their academic studies (GADOE, 2016). Students need frequent

opportunities to solve real world problems that require a significant amount of effort and reflect

on their thinking during the problem-solving process so that they can apply and adapt the

strategies they develop to other problems in other contexts (NCTM, 2016). Traditional, gender-

biased teaching methods for mathematics instruction may be contributing to the

underrepresentation of females in higher-level mathematics courses and associated career fields

(Hoffmann & Haussler, 1998). In contrast to traditional methods, research has shown that

middle-school females thrive when math instruction is socially supported through peer

interaction and peer acceptance (Cerezo, 2004).

Problem-Based Learning

PBL is a student-centered pedagogy in which students learn content as well as critical

thinking skills. This approach to learning also teaches vital problem-solving skills (Hmelo-

Silver, 2004). According to Dewey, actions, the meaning of words and observations, are

continuously re-negotiated within the context of active inquiry rather than being considered

fixed. Dewey (1938/1991) stated, "…words mean what they mean in connection with conjoint

activities that affect a common, or mutually participated in, consequence" (p. 59). In considering

Dewey's words, PBL with its collaborative, experiential, and interactional nature allows students

to co-construct knowledge and make meaning of context-based problem solving.

Vygotsky believed that knowledge is acquired through construction of knowledge within supportive situations called the zones of proximal development (ZPD). The ZPD is, "…the distance between the actual development of a child as determined by the independent problem-solving, and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more knowledgeable peers" (Vygotsky, 1978, p. 86).

The social nature of collaborative learning lends itself to fulfilling the developmental needs of "at-risk" females (Cerezo, 2004). PBL is a teaching method that is experiential, collaborative, and interactive; all of which provide equitable opportunities for mathematics achievement for "at-risk" middle-school girls. Furthermore, studies suggest that placing an emphasis on student support, excellence in academics, and equity helps increase female students' self-esteem (Archer, 1993).

PBL came into focus in the 1960's when faculty at McMaster University in Ontario, Canada applied PBL to its curriculum for medical students; Case Western University soon followed suit. To date, over 80% of medical schools across the United States use some form of PBL (Vernon & Blake, 1993). PBL is, "…focused, experiential learning (minds-on, hands-on) organized around the investigation and resolution of messy, real-world problems" (Torp & Sage, 2002, p. 15).

Originating in medical schools, the PBL curriculum was developed to encourage and aid students to see the relevance of learning. Another goal of PBL development was to instill a higher level of student motivation towards learning and to show the importance of a responsible professional attitude (Barrows, 1996). The collaborative and interactional nature of PBL, elements missing in traditional teaching methods, has been found to aid in the development of problem-solving skills especially among "at-risk" females (Cerezo, 2004).

The PBL process begins with the facilitator grouping students and then giving each group a real-world problem that is ill-structured. At this point, students will not have been exposed to lessons on the specific content and will need to determine the statement of the problem. To formulate the problem statement, the group collaborates and analyzes what is known and what should be known in order to resolve the issue. A written statement, which is agreed on by the group, is created and usually, instructor feedback is included prior to the final draft of the problem statement. It is also common for the problem statement to be edited as new information becomes available and old information becomes irrelevant.

Students then begin to discuss possible theories while the facilitator provides scaffolding, which is the framework on which students can co-construct knowledge relating to the problem. Next, students decide who will research each of the key points and then regroup after the research is complete to finalize a possible solution.

Research indicates that "at-risk" students improve in mathematics when learning opportunities nurture peer relationships. PBL is consistent with meeting the developmental needs of females, "…pbl includes resource identification, peer support, acknowledgment and continued reinforcement of existing knowledge and assistance and assurance in integrating and synthesizing new information" (Lambros, 2002, p. 3). During early adolescence, boys are becoming more in tune with involvement and participation with competitive sports (Maccoby, 1998). On a cultural level, girls are rewarded for being, "…timid, cooperative and quiet" (Tozer, Violas, & Senese, 2002, p. 392); whereas, boys are encouraged to become risk-takers who are assertive and stand out from the pack (Feingold, 1994).

Seventh-grade students are at the precipice of their teenage years and stand at the doorstep of puberty. At this point in their lives, gender differences begin to emerge, as females develop a preoccupation with how others perceive them and with their physical appearance (Cerezo, 2004). Females also become preoccupied with societal acceptance, particularly from their peers, and develop a need for more social support and interaction (Schunk, 1996). The PBL method of teaching offers students, particularly beneficial for female students, the opportunity to collaborate on content and build peer relationships as well as gain validation of mathematical ideas from peers (Cerezo, 2004).

Many believe that there is a job crisis on the horizon for our country. For 2018, almost 2.5 million STEM-related job openings have been projected, and there is growing concern that many graduates will not meet the requirements to fill these jobs. For every two STEM openings only one candidate will meet the qualifications (Carnevale, Smith, & Melton, 2010). Increased females participation will be needed to help relieve the pressure of growing demands in STEM-related careers. Females need to be encouraged to enroll in higher-level mathematics classes in middle and high school so that they are in a position to fill the requirements for STEM-related careers. A report filed by National Public Radio stated that females make up 51% of the work force and yet only 20% of all U.S. computer programmers are female (Sydell, 2013).

Background of the Study

Based on what is known about seventh-grade students and their developmental needs during early adolescence, gender-biased teaching methods may severely impact the empowerment of students considered at risk and may contribute to the underrepresentation of females in higher-level mathematics courses and associated career fields. The present study investigated a more

equitable teaching method to serve the learning needs of "at-risk" students and, particularly, female students.

In line with a liberal feminist perspective, one primary goal is to examine how PBL meets the developmental needs of middle-school female students. Liberal feminists believe that they can work from within the mainstream society to integrate women (Moore, n.d.). Liberal feminists seek sameness or equality with men via legal and social reform, and thereby, look to reform present societal practices (Moore, n.d.). Societal changes such as attitudes towards the abilities of females might be one way to encourage and empower females, thus positively impacting the underrepresentation of females in STEM fields. Feminist standpoint theory's basic tenet is to show the value of women's experiences as a point of resistance to the male domination of certain fields of study such as in mathematics and the sciences (Fennema & Hart, 1994).

Negative societal beliefs toward the abilities of females in positions such as STEM careers may set females up for failure. This negative belief may feed into something known as stereotype threat, which is a situational predicament in which people feel themselves to be at risk of confirming negative stereotypes about their social group (Inzlicht, 2011).

But how can we expect to diminish issues, such as stereotype threat, in the minds of our female students when they are exposed to evidence of it on a daily basis? Such evidence came in the remarks from the former President of Harvard University and former Secretary of the Treasury in 2005, Lawrence Summers, who alluded to what he believes to be the reasoning behind the underrepresentation of women in STEM-related fields as, "intrinsic aptitude," or in other words, lack of cognitive ability.

Could gender really be the reason that females do not perform to the level of males in mathematics? The answer to this question, some critics would argue, is not a simple one. When we look at the areas of mathematics that males tend to exceed in, we find geometry to be their strong suit (Guiso, Monte, Sapienza, & Zingales, 2008). One reason may be that males are much more developed in areas of spatial reasoning (Halpern, 2004). Interestingly enough, spatial reasoning is of paramount importance in the thinking process of engineers, architects, inventors, and mathematicians and in disciplines such as mathematics, physics, and computer science. Spatial ability can be defined as the capacity to understand and remember the spatial relations among objects. This ability can be viewed as a unique type of intelligence distinguishable from other forms of intelligence, such as verbal ability, reasoning ability, and memory skills (Wai, Lubinski, & Benbow, 2009).

The facts are clear that women are underrepresented in higher-level mathematics courses and STEM related career fields (American Association of University Women, 2008). There has been no shortage of research seeking to understand why females are not performing at the same level as males in STEM courses and STEM careers. However, one could make the case that females outperform males in other areas such as verbal test scores and reading (Halpern, Benbow, Geary, Gur, Hyde, & Gernsbacher, 2007). Critics might argue that the focus is misplaced by exploring the gender gap in mathematics, and therefore, feel that the gender gap in these other areas, where females are outperforming males, are just as important.

Why not research the gender gap in these areas rather than focusing efforts on the gender differences in mathematics? One reason may be the effect that mastery of mathematics may have on income potential of the individual. More so than verbal test scores, mathematics test

scores are a good indicator of future income (Niederle & Vesterlund, 2010). Even though the

degree to which the effect of mathematics performance on future income varies, the significant

effect is consistently supported in study after study (Weinberger, 2001).

Still, the question persists as to why there is such an underrepresentation of females in higher-

level math courses and STEM career fields. One theory compares male and female students who

are equally matched in mathematical ability and aptitude. Research (Ceci & Williams, 2010)

found that when this is the case, in addition to having an aptitude for mathematics, females also

may have superior skills in verbal ability, which translates to them having more options in other

fields. Having more options, coupled with a lack of interest in mathematics, may be a plausible

reason for the underrepresentation, whereas males may only have the mathematics option.

Females can consider math-oriented fields as well as law, social sciences, humanities, and

medicine (Ceci & Williams, 2010).

Another theory that aims to answer why women are underrepresented in STEM fields states

that women are socialized away from mathematics. Two separate studies found the actions of

teachers and parents could play a role in how female students view their mathematical abilities.

Both studies found that teachers may be giving male students preferential treatment, which

signals to females that they are not as worthy. When you compound this, with parents' lower

expectation of their daughters' performance in comparison to their sons' mathematical

performance, you begin to understand the societal aspect and the role it may play.

The average American may not understand the need for an immediate call to action regarding

the social implications of the underrepresentation of women in STEM careers. However,

consider this; the majority of single parents in the United States are mothers who are still earning

only 77 cents for every dollar that their male counter-parts earn (Islam, 2015). Now consider that there are more opportunities within STEM-related careers than any other industry, and we should recognize, these high-tech jobs pay very well.

According to the National Council for Women and Information Technology, by the year 2020, there will be an estimated one and a half million number of computer specialists job openings. In order for women to claim their fair share of these jobs, they will need to possess the necessary credentials, including a STEM-related degree. A higher standard of living can be realized for American women through STEM-related careers, thus, ensuring job security as well as financial security. As a matter of social justice, females should be encouraged to pursue these careers to the same degree as males.

As a society, we need to change the way we think as well. Sandberg, Chief Officer of Facebook, witnessed firsthand, albeit on a small scale, our gender-biased thinking in action as it relates to our daughters. Sandberg describes the scene at a Stanford Technology camp where 35 spots were available. The camp was a success, with all spots filled; however, girls only filled five spots, two of which Sandberg signed up. What message does this send to our daughters regarding our belief in their abilities in mathematics and engineering?

Our societal expectations are not the only reason for the gender gap; however, it certainly feeds the problem. We subconsciously program or socialize our daughters away from STEM-related fields. This is most evident when we consider countries like Iceland, where gender equality is greater, and they have almost erased the gender gap in mathematics (Guiso, Monte, Sapienza, & Zingales, 2008).

Research Problem

Students considered at risk are not well served by traditional teaching methods in mathematics (Faller & Holden, 2015). Traditional teaching methods, found in the majority of mathematics classrooms, are based on a traditional skills model (Becker, 2003) where memorization and rote recitation are the norm rather than active, collaborative, concept-based learning. Traditional teaching methods are inequitable because they do not meet the developmental needs of female students and also many "at-risk" male students (Lerner & Sadker, 1999). These teaching methods promote a competitive atmosphere that is conducive to learning for some males, but offer only marginalized opportunities to female and "at-risk" male students (Lerner & Sadker, 1999). Furthermore, these teaching methods appear to create inequitable differences between males and females in mathematics learning, which become more pronounced, creating a gender gap as they progress through middle school.

The social implications have far reaching effects in terms of gender equality (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011). Consider the modest number of females who actually receive STEM degrees, largely concentrated in physical and life sciences, as compared to their male counterparts with STEM degrees who dominate the field of engineering (Beede et al., 2011). Despite the fact that the wage gap is smaller for STEM careers than any other field, most females still choose careers in fields other than STEM (Beede et al., 2011).

Educators need to understand what teaching methods will give rise to success for females and other "at-risk" students. More research needs to be done, especially qualitative research that investigates successful teaching methods for female students in mathematics. Specifically, there is a need to investigate the perceived effectiveness of PBL in mathematics for female students

and other "at-risk" students. In particular, there is a lack of research that explores in depth the influence of gender on students' perception of learning and motivation in PBL math classes.

The current gender-biased teaching methods have done little to close the achievement gap between males and females in mathematics (Beede et al., 2011). These current teaching methods assume students are empty vessels that need to be filled with knowledge, and these methods do little to contribute to the process of learning (Freire, 1970). The current teaching methods emphasize a competitive and individualistic learning environment reliant on memorization rather than co-construction of knowledge. This learning environment stifles the voices of females, as well as other students considered at risk of failure, and creates causalities of curriculum.

In attempting to improve mathematics education for "at-risk" middle-school students, it is important to know if students perceive PBL to be an effective teaching method and how these perceptions are influenced by gender. Particularly, does PBL meet the perceived needs of "at-risk" female students? Also, does it meet the perceived needs of "at-risk" male students, but for different reasons? Learning processes such as motivation, concentration, confidence, comfort, interest and anxiety will be considered by students when giving perceptions of PBL. Exploring students' perceptions of PBL should help to understand more deeply their different needs and how to address those needs.

Research Purpose

The present study is exploratory in nature as the researcher attempts to gain insight into whether PBL is perceived as an effective teaching method for "at-risk" middle-school students in mathematics. The purpose of this exploratory case study was to understand the perceptions of

"at-risk" seventh-grade students after their experience with PBL and investigate gender influences on their perceptions. I wanted to determine if PBL could effectively meet the perceived needs of "at-risk" students and provide an equitable method of teaching for females and "at-risk" male students.

Research Questions

As a math teacher, I continually see students who are at risk of failing math, and thereby, can identify several of the main issues that seem to create barriers to their success in math. One issue that I see firsthand is a lack of confidence, especially for female students and "at-risk students" in general, which compounds their lack of interest and low achievement in learning mathematical concepts; all of which are vital to success in later grade levels and higher-level mathematics courses.

The three questions guiding this study focused on students' perceptions of learning, motivation, and the influence of gender on these perceptions.

1. A. In what ways do "at-risk" seventh-grade female students who have been involved in PBL math classes perceive changes in their learning processes?

   B. In what ways do "at-risk" seventh-grade male students who have been involved in PBL math classes perceive changes in their learning processes?

2. A. In what ways do "at-risk" seventh-grade female students who have been involved in PBL math classes perceive changes in their motivational processes (e.g., confidence, interest, anxiety)?

B. In what ways do "at-risk" seventh-grade male students who have been involved in PBL math classes perceive changes in their motivational processes (e.g., confidence, interest, anxiety)?

3. In what ways do gender differences influence the perceptions of learning and motivational processes by "at-risk" seventh-grade students who have been involved in PBL math classes?

The first question focused on how "at-risk" seventh-grade math students who have been involved with PBL perceive changes in their learning processes. Finding a mathematics teaching method that is perceived to be effective by students considered at risk is only part of the issue; the other part is creating an environment where students become engaged learners who construct knowledge. Therefore, this study was also guided by the second question.

In middle school, the differences between males and females and their learning styles are much more pronounced as compared to elementary school. The sociological and neurobiological changes that occur in male students may explain why males think and engage in the learning process differently (Feinstein, 2004). These changes may account for the cognitive and effective gender differences and their approaches to problem solving. This is the basis for the third question. In other words, how do the boys and girls who have been involved in PBL math classes perceive the learning and motivational processes differently and/or similarly?" This study, in general, will look for gender differences among students to see if there are perceived changes to their learning after involvement with PBL.

Definition of Terms

The following terms are defined in this study: "at-risk" students, gender-biased teaching methods, problem-based learning, learning processes, and motivational processes.

"At-risk" student is one who may exhibit multiple characteristics such as low-test scores, poor attendance, discipline issues, lack of structure at home, and low-socioeconomic status. "At-risk" students usually struggle in several areas and those struggles often have an adverse effect on students' performance at school. The term, "at-risk" applied to students is set off by quotation marks to avoid labeling and to indicate that students are often placed at risk by environmental conditions such as inequitable teaching methods.

Gender-biased teaching methods are the highly individualistic and competitive approaches to teaching that appear to favor male students. These approaches are usually teacher centered and directed, and students must publicly vie for the attention of the teacher and are pressured to outperform other students. The problematic nature of these competitive teaching approaches are further exacerbated for "at-risk" female students when teachers primarily rely on lecture and students passively sit and memorize facts for tests (Lerner & Sadker, 1999).

Problem-based learning is "…focused, experiential learning (minds-on, hands-on) organized around the investigation and resolution of messy, real-world problems" (Torp & Sage, 2002, p. 15). This student-centered, collaborative approach allows students to examine a problem scenario, and then determine what is known and what needs to be explored to give resolution to the problem. The design of the problem is such that there is not just one way to resolve the issue; therefore, there is not just one correct answer. The goals of PBL are to help the students develop

flexible knowledge, effective problem-solving skills, self-directed learning, effective

collaboration skills, and intrinsic motivation (Hmelo-Silver, 2004).

Learning processes are the perceived ways that students reported constructing knowledge of

mathematics. The perceived changes in student learning processes refers to the difference that

the students reported in their learning processes after involvement in PBL math classes.

Motivational processes are the perceived influences—confidence, interest, comfort, and

anxiety—that students reported positively or negatively affecting their learning processes. The

perceived changes in students motivational processes refers to the difference that students

reported in their motivational processes after involvement in PBL math classes.

Theoretical Perspective

Sociocultural theoretical perspective is the theory guiding this study and is based on the

notion that we learn through social interaction. "Socio" indicates the social aspect, and "cultural"

indicates the influence of our cultural backgrounds. This theory suggests that we learn from the

culture in which we live including the influences of our parents, caregivers, teachers, peers, and

other cultural influences. Hence, knowledge is constructed in a sociocultural context.

Sociocultural theory was introduced by psychologist, Vygotsky (1978), who believed, "Every

function in the child's cultural development appears twice: first, on the social level, and later, on

the individual level; first, between people and then inside the child" (p. 57).

Vygotsky proposed the Zone of Poximal Development (ZPD) as a way to assess a child's

maturing psychological functions (Clara, 2016). Vygotsky's intentions with ZPD were geared

toward development and maturing mental functions. Ultimately, researchers began to apply the

concept of ZPD within educational setting to examine instruction and skill acquisition (Wood & Middleton, 1975).

Vygotsky attached a very specific meaning to the word instruction; the collaboration between a child and an adult where the adult forms a meaning, which is new for the child, and the child imitates that new meaning. This exchange between the child and adult was referred to by Vygotsky as intellectual imitation or meaningful imitation (Vygotsky, 1987, p. 210). Vygotsky's use of the word instruction was referred to as "instruction based on intellectual imitation," which is clearly not the same as inquiry-based instruction.

Wood and Middleton (1975) focused on a concept similar to Vygotsky's ZPD in which a child, in the context of an educational setting, could work with a knowledgeable other, and accomplish more with the aid of the other until he or she could accomplish the task on his or her own. This distance between what a student could do alone and what they could accomplish with the aid of another is known as the region of sensitivity to instruction. Wood and Middleton posit that there is a classification of degrees in instruction in which, at that time and for a given task, a student can be identified as being at a certain level. Either above or below that level can yield results of failing or success respectively. In other words, above that particular level, for that particular task, will result, generally, in failure and below that level results in success.

Cultural beliefs, background, and attitude also influence an individual and their engagement in learning. Donato and McCormick (1994) describe sociocultural theory and the collaborative learning environment in terms of "… social interaction and cultural institutions, such as schools, classrooms, etc., have important roles to play in an individual's cognitive growth and development" (p. 456). Scimsher and Tudge (2003) noted that while Vygotsky was interested in

the broader cultural and historical settings that shaped learning interaction, he was also interested in what the learner himself brought to the learning process (Wood & Middleton, 1975).

The present study examined students' perceptions of collaborative and interactive PBL classes, which allowed the students to co-construct new understandings of mathematics. This collaborative approach to problem solving was consistent with the tenets of sociocultural learning. Furthermore, studies have shown that students working together perform better than those working alone (Lumpe & Starver, 1995). The views of others, especially the peers of adolescents, are the greatest source of alternative views to challenge current views, and hence, to serve as a major source of puzzlement that stimulates new learning (Von Glaserfeld, 1989).

Researcher's Perspective

The decision to pursue the research problem stated in this paper arises from personal experience in my current position as a mathematics teacher in a Title I school. Frustration runs deep on both sides, for the teacher and the student, when current teaching methods are inadequate for yielding success. For me, student success is not simply being able to perform well on a test, but rather the ability to demonstrate understanding of a concept by using it as the foundation for the next mathematical concept taught. Mathematics is foundational and the concepts learned this year become the prerequisite skills next year; however, if students cannot retain the methods on how to perform algorithms for certain concepts, then they will not be able to build on that foundation.

I believe that students, to a certain extent, need to discover concepts for themselves via teaching methods like PBL because this makes the learning process more meaningful for them. When concepts are truly learned, students do not need to remember rules or gimmicks to perform

the algorithm, but instead, they can analyze the problem, as each situation and problem is unique, and devise a method to solve it using sound mathematical reasoning. Because of this, I became interested in experiential teaching methods, such as PBL, and at this point, I am certified in PBL through the CERTL Institute, The Center of Excellence for Research, Teaching and Learning, at Wake Forest University. My motives are subjective to the extent that I believe in experiential learning and think that it can reach students considered at risk, especially females. I believe that the findings showed that PBL was effective with "at-risk" students because it coached students to admit when they did not understand and modeled the learning process of seeking assistance from a group of peers to gain understanding of the math concept. I am very passionate about this study because I believe it made a difference in the motivation and self-efficacy of those students who may have been marginalized by traditional teaching practices.

Significance of the Study

More than a million students leave school each year without a traditional high-school diploma, which in part may be due to mathematics teaching methods that do not match the learning needs of "at-risk" students. The cost to society for our high dropout rates include higher incidences of crime, lower tax revenues, and greater public spending on public assistance and health care (Tyler & Lofstrom, 2009). Another fact that underscores the importance of this study includes the underrepresentation of females in higher-level mathematics courses and associated career fields that require advance mathematical skills. Consider the fact that women earn only 29% of mathematics and computer science bachelor's degrees, and only 24% of doctorate degrees in mathematics and computer science; and furthermore, women hold only 27% of the professional mathematics and computer science positions (Hill, Corbett, & Rose, 2008).

Accordingly, there is a great need to understand which teaching methods are effective with female students. We need to find teaching methods that empower students who are otherwise marginalized by current inequitable teaching methods.

Therefore, this case study is important to the field of curriculum studies because it sought to find equitable teaching methods as an alternative to traditional gender-biased teaching methods, which limit the potential achievement of females and other "at-risk" students in mathematics education. If we can find teaching methods that empower our students in a way that helps them to see the relevancy in the mathematical concepts being taught, then their chances of graduation are greater.

The "gender gap" is partially to blame for the discrepancy; however, factored into the gender gap is the "confidence gap." Confidence influences interests, goals, performance and persistence (Eccles, 1994). This fact is evident when you consider how differently males and females define and perceive success. As an example, consider grades in math class—a girl might perceive a B as a poor grade because it is not an A, whereas, a boy might perceive a C as confirmation of his strong mathematical ability because it is still considered a passing grade (Seymour, 1995).

The remedy for this inequitable dichotomy may lie in experiential teaching methods where students are encouraged to take ownership of their learning. Experiential teaching methods are particularly valuable due to the fact that these methods show students how to think and learn. Using PBL experiential teaching strategies, students can potentially use what they learn in other areas of their life because they are also learning critical problem-solving skills at the same time. This is especially germane if these experiential teaching methods can empower those in our society most marginalized. PBL teaches students that asking questions is a positive rather than a

negative. Through the PBL process, asking questions and doing research, students learn that they can solve problems when given adequate information rather than blindly coming up with a solution. Asking questions and getting feedback and validation from peers helps students to learn and feel successful.

Traditional, inequitable teaching practices in mathematics education have focused on learning facts and concepts in isolation through the use of rote memorization often leading to a disconnect for the student in terms of application of these concepts to real world problems. Teaching methods should prepare students to think critically and use problem-solving skills adequately.

In the mid-80's, there were thirteen boys for every girl who scored above seven hundred on the SAT math exam at age thirteen; today that ratio has shrunk to about three to one ratio. This increase in the number of girls identified as "mathematically gifted" suggests that education can and does make a difference at the highest levels of mathematical achievement (Hill, Corbett, & Rose, 2010). One such method that teaches these skills is problem-based learning, which has also shown to be effective in empowering females in areas such as mathematics (Cerezo, 2004). It is typical for "at-risk" students to have negative attitudes when it comes to mathematics, and their perceptions may be based on the lack of confidence in their ability and the lack of value that these students see in the mathematical concepts being introduced. Accordingly, we need to teach these concepts in a way that emphasizes relevant value and promotes a confident expectancy of success.

Our society benefits if we can establish strong mathematical foundations for seventh-graders because, as previous research has suggested, this transitional time is pivotal in terms of predicting whether a student will dropout or graduate. As educators, our focus needs to be on

building the confidence of "at-risk" students and showing relevancy of material in areas such as mathematics, especially at critical junctures and transitional periods like seventh-grade. Peer support and validation of facts and possible problem solutions aid in students becoming active problem-solvers rather than passive listeners. If students feel confident and secure in their ability now, this may ultimately translate to STEM careers later. Experiential teaching methods, such as PBL, can possibly accomplish both of these tasks and possibly increase the graduation rate for "at-risk" students and level the playing field of the underrepresentation of females in STEM discipline careers.

Organization of the Study

Chapter two will proceed to review relevant literature from the most general information to the most specific. It will begin with an explanation of the sociocultural theoretical perspective and then integrate and analyze the existing literature available on "at-risk" students, especially female students, and teaching methods used to increase their confidence and empower them in mathematics. This chapter will include studies that have used PBL to increase student confidence in the middle- or high-school level in mathematics or other core area subjects. Other literature will consist of studies that target female achievement and confidence in mathematics at the middle- and high-school levels, especially where the teaching method is being examined for causation.

Chapter three will describe the case study methodology that I used for my study. The present study considered multiple perspectives for the purpose of gaining insight into the perceptions of sixth-grade problem-based learning (PBL) students. As such, this case study employed a bounded system case study design that was qualitative in nature.

In this chapter, I will also describe how the participants were selected for the present qualitative case study. Additionally, in chapter three, the criteria used to select participants will be explained. I will also explain the curriculum unit of PBL and how it was used within this study. I will delve into the mathematical concepts that were covered and the timeframe in which the concepts were taught. The PBL materials used for the study will be explained, as well as PBL certification and proper procedures. Finally, chapter three will expound on the limitations, data collection and analysis, which will be explicitly explained and outlined for the present study.

In Chapter Four, the results will be stated. A summary of the data collection and the results achieved along with details that justify the conclusion will be presented. Finally, chapter five will consist of a discussion of the thematic findings and as well as educational implications and recommendations for PBL in the classroom.

Summary

PBL gives students multiple perspectives on the concepts being taught and they are able to take ownership of their learning. The fact that PBL is based on co-construction of knowledge in a collaborative learning environment may be well suited for meeting the needs of "at-risk" students as well as females. By the time girls get to middle school, research indicates that they are struggling with their academic competency and have become tentative about speaking up in class (Cerezo, 2004). They also place a high value on peer acceptance and need social support, which is in line with the collaborative, social support, and interactive elements of PBL.

CHAPTER 2

REVIEW OF THE LITERATURE

Students at risk of failing mathematics early in school should be a societal and educational concern, as these students will very likely suffer academic and career consequences later. There should be serious concern paid to the issues surrounding current, ineffective teaching methods in mathematics classrooms as they may be a contributing factor in the under enrollment of females and students considered at risk in higher-level math courses as well as the underrepresentation of females in STEM related careers.

Teaching methods used in a mathematics classroom may have far reaching effects; accordingly, care must be taken to ensure that the time spent in math class motivates students and meets the individual needs of those students. Despite the fact that women earn nearly half of all college degrees each year, only 28% of women worked in a STEM related field in 2010; which is an increase from 21% in 1993 according to the National Science Board's 2014 "Science and Engineering Indicators" report. Dismal statistics such as this show how truly underrepresented females are in fields such as engineering and other mathematics related careers.

Vygotsky's sociocultural developmental theory (Vygotsky, 1978) is consistent with experiential learning (Wood & Middleton, 1975). PBL, a branch of experiential learning, came into focus in the 1960's when medical schools began using this teaching method. To date, over 80% of medical schools across the United States use some form of PBL (Carlson, 2010). PBL is, "…focused, experiential learning (minds-on, hands-on) organized around the investigation and resolution of messy, real-world problems" (Torp & Sage, 2002, p. 15).

Barrows, a trained neurologist, best known for advances in medical education and particularly the PBL method, began his inquiry into PBL in 1971 while at McMaster University in Ontario. Ten years later, Barrows moved to Southern Illinois University Medical School as Associate Dean. During his tenure at Southern Illinois, Barrows established the PBL track model, which was based on the PBL curriculum at McMaster University.

PBL is student-centered and is closely related to inquiry-based learning and a variant of project-based learning. Within PBL there are multiple variations. Among those variations, the most widely recognized are problem-stimulated, student-centered, and case-based PBL (Bridges, 1992). Although most forms of PBL contain the basic elements, there are subtle differences. Medical schools, such as Wake Forest, and their PBL program, maintain that only light distinctions exist in the varying forms of PBL and very little foundation exists in the literature for these subtleties.

The problem-stimulated approach is used to introduce new knowledge and employs role-relevant problems to do so. The basic goal of this approach is similar to the basic goals of PBL; however, this approach also has some additional goals. Problem-stimulated learning focuses more so on (a) developing domain-specific skills (b) developing problem-solving skills, and (c) the acquisition and mastery of domain-specific knowledge (Bridges, 1992).

The student-centered approach shares the same goals as problem-stimulated but incorporates one additional goal. It requires a life-long learning skill to stay current in your field of practice. It also instills in the learner, a desire to never discard the learning process. This additional goal is particularly valuable for those in professions that require periodic, mandatory education in order to maintain credentials in their field of expertise, such as physicians. Differences exist between

this approach and the problem-stimulated approach, for instance, students using the student-centered approach identify the learning issue to be explored; they also determine the content to be mastered and they must locate the resources to be used.

The case-based method is an approach to PBL that exposes students to a design challenge; students must create a solution using only prior knowledge. The collaborative setting is especially important because students must use each other to compare and contrast ideas, choose a learning issue on which to focus, and develop an activity to examine the learning issue.

The PBL method that I used for my study is problem-stimulated PBL (Bridges, 1992). The facts supporting my case study include the notion that this particular method of PBL emphasizes the acquisition of domain-specific knowledge. In mathematics education, it is critical that the student is able to both, think critically and also problem solve. However, the mastery of specific skills also comes into play as mathematics is foundational, and each set of skills is built on the previously mastered skills.

In the world of education, there has been confusion between "problem-based learning" and "project-based learning" with the terms being used interchangeably, for which they most certainly are not. And, although the two concepts share certain common ground, the differences must also be discussed (Table 1). Perhaps the biggest difference between these two teaching methods lies largely in their application. Project-based learning focuses on the product, while problem-based learning focuses on the problem and the process (Savery, 2006). Another major distinction between project-based and problem-based learning is the actual nature of the problems being addressed in the particular problems. Within project-based problems, the

problem is an authentic problem that exists in the world, but within problem-based problems, the problem is a crafted problem or scenario (Larmer, 2014).

Students participating in problem-based learning share the outcomes and jointly set the learning goals whereas, project-based learning is an approach where the goals are pre-determined. Also, project-based learning involves multiple subjects in one problem while problem-based learning is more likely to be a single subject and shorter in length. Generally, project-based learning follows general steps while problem-based learning provides specific steps.

Table 1

Problem-Based versus Project-Based Comparison

Problem-Based versus Project-Based Comparison	
Similarities	
Both PBLs:	
• Are student-centered and are inquiry driven.	
• Provide application of content and skill.	
• Are more extensive and multi-faceted than traditional teaching methods.	
• Focus on an open-ended task or question.	
Problem-based learning	**Project-based learning**
Usually uses an ill-structured or messy problem that is fictional.	Uses real-world problems.
Most often a single subject, but can incorporate multi-subject.	Interdisciplinary, incorporating several subjects.
Usually shorter in length with exceptions.	Usually lengthy in nature (could last weeks or months).
Follows a systematic procedure.	Follows general guidelines.
The product can be tangible or a presentation outlining solution.	Includes the creation of a product or the creation of a performance.

This chapter, in an effort to present the relevant literature, is divided into two sections. Both sections offer important perspectives on collaborative teaching methods bridging the gender gap in mathematics and issues concerning students considered at risk. The first section is a review of

the theoretical frameworks for studying the perceptions of students considered at risk in collaborative and experiential learning environments. The second section consists of a review of the studies related to experiential learning, perceptions of "at-risk" students and the mathematics gender-gap.

Theoretical Framework

The sociocultural theoretical perspective will be used as the framework for the purposes of this study. Sociocultural theory, developed through the work of Vygotsky, posits that social interaction plays a fundamental role in the development of cognition. The sociocultural perspective consists of several core principles upon which the theory is centered. These principles are: (a) children construct their knowledge, (b) development cannot be separated from its social context, and (c) language plays a central role in mental development. This theory suggests that social interaction leads to continuous step-by-step changes in children's thought and behavior, which can vary greatly from culture to culture.

The tenets of sociocultural theory are closely matched with the principles of PBL. Three major themes can be seen in Vygotsky's (1978) sociocultural theory: (a) social interaction is fundamental in the process of cognitive development, (b) the more "knowledgeable other" is anyone or thing (computer) with a better understanding of the material that can assist the learner to achieve a higher level, and (c) the distance between an individual's ability of working independently and their ability with the aid of a "knowledgeable other" is known as the zone of proximal development (ZPD). If we compare these themes in Vygotsky's theory to the method of PBL, we can see that there is a distinctive match between them because PBL subscribes to all of these themes.

Comparing each of the above referenced themes found in Vygotsky's theory to PBL, we find: (a) social interaction is also a necessary part of PBL, (b) the more "knowledgeable other" is also vital to PBL, as this is the collaborative element at work within PBL, and (c) ZPD is where the learning takes place within PBL because this is where students are able to give social and academic support to their peers within the group (Wood & Middleton, 1975).

Additionally, the culture provides certain tools that help children navigate and form their perceptions of the world. Language, according to Vygotsky (1962), is the most important tool as it aids in reasoning and organization of thoughts and communication. These cultural tools, which can be psychological as well as physical, can be passed from one individual to another by means of imitating, direct instruction or collaborative settings.

Within sociocultural theory, the focus is on how social interaction influences development. Children construct their knowledge and learn information from a myriad of social sources. Caregivers, immediate family, and teachers, among others, have a tremendous impact as children first learn the language and culture from those with whom they have the most interaction during their development.

As children participate in a range of activities with members of their culture, they internalize these experiences, and develop their own knowledge, tools and strategies to navigate through life. Within this theory, children develop and use tools, such as language initially, to communicate needs; however, once these tools are internalized, higher-order thinking skills begin to develop. An example of this may be a young child talking to herself as a way of understanding something new, but as the child develops, the self-talk is internalized and becomes only a whisper (Gallagher, 1999). These cultural tools known as semiotic means (Vygotsky,

1981) range from, "language, various systems of counting; mnemonic techniques; algebraic symbol system; works of art; writing; schemes, diagrams, maps and mechanical drawings; all sorts of conventional signs and so on" (p. 137). Today, there are other objects that are recognized as tools such as paintbrushes, computers, and calendars.

According to Wertsch (1994), semiotic mediation connects the external with the internal, the social with the individual, and is key to understanding how mental functioning is tied to cultural and historical settings, since these settings provide the cultural tools with which individuals form their thinking.

Feminist Perspectives on Mathematical Education

Feminism is a complex topic especially when applied to the influences of gender surrounding a discipline such as mathematics. "Feminism is the refusal to define all women and therefore all human beings solely in terms of sex" (Castro, 1990, p. 2). Feminist theory is based on the fundamental belief that we live in a male-dominated culture where men have developed the standards for society.

Feminist perspectives almost always center on interpreting the world and its components from a female's viewpoint. Many feminist scholars have contended that our view of most concepts is shaped though masculine eyes (Fennema, 2000). Considering this, we turn our attention to disciplines, such as science and mathematics, where most feminists believe there exists a masculine bias (Fennema, 2000). Feminists are beginning to add their voice in an attempt to reshape these disciplines, however, the majority of feminist scholars work outside the areas of mathematics and science.

In dealing with the complexity of gender and mathematics, we must consider the dichotomy between feminist essentialism and non-essentialism. To what can we attribute the underrepresentation of females in STEM courses as well as STEM-related careers? Do the biological differences between males and females account for these disparities or does it have more to do with the social aspect?

Within feminist discussions of essentialism, it is difficult to identify any central themes because there is a vast array of strands (Stone, 2004). However, one theme remains constant, essentialists posit that gender, sexuality, race, ethnicity and other group characteristics are fixed traits and there is no accounting for other variations among members of the group. The basic premise is that men and women are biologically different. Essentialist feminism recognizes and focuses on the obvious and true differences between males and females. In essence, men and women are different but equal in value as opposed to an anti-essentialist view. The fixed properties that tie women to this particular group are biological in nature, breasts, womb and childbearing capacity (Stone, 2004). Therefore, essentialism transitions into biological essentialism as these female attributes, which connect women to a particular group, are most certainly biological in nature.

Being categorized as a woman within feminist essentialism may require certain physical attributes. However, anti-essentialism suggests that concepts such as femininity and gender are socially constructed, and therefore calls into question what it means to be a woman (Stone, 2004). Outward appearance alone is not enough to constitute gender or ties to a particular social group. Anti-essentialism contends that concepts such as gender, femininity and sex are open to interpretation and are social constructs. The core argument against essentialism is anti-

essentialism, where essentialists mistake what is social and variable for what is natural and fixed (Witt, 2010). Viewing sexist oppression through the lens of an anti-essentialist, they believe that it doesn't take the form of explicit discriminatory laws or lie within our individual psyches. From an anti-essentialist view, a large part of the problem lies in the gendered nature of the societal norms that have been assigned to individuals.

The issue of females and STEM may not be solved by solely looking at what makes one female or concentrating on the differences between males and females but rather by examining how females learn. The challenges related to gender and mathematics should not be viewed as female deficiencies such as a lack of confidence, spatial skills or other deficiencies in intellect (Fennema, 2000). Instead, we need to look closely at where gender differences in mathematics surface and we should question what mathematics is being measured in tests when gender differences are either shown or not shown (Fennema, 2000).

If the goal is to incorporate female voices into the discussion regarding mathematics, then perhaps feminist standpoint theory may offer valued insight. This theory maintains that, "feminist research about girls and women would seek to help them understand and transform their place in mathematics education rather than working to identify differences between female and male students" (Fennema & Hart, 1994, p. 655). The female voice that feminist stand point theory would seek to incorporate includes the opportunity and confidence to ask questions, discuss and explore ideas, pose problems, and feel that they have something to say and have the right to say it (Charlene Morrow, personal communication, April 12, 2001). This is in line with the sociocultural theoretical perspective of collaboratively exploring ideas and concepts with one's peer group.

Feminist standpoint theory suggests that, yes females are all part of a particular group, but within that group, there are differences. This theory, as it is applied to mathematics, recognizes that females bring both positive and negative experiences as well as mathematical and non-mathematical experiences to the learning process. Thus the uniqueness of each individual is acknowledged within the learning environment (Damarin, 1995). The multiple identities of students must be considered, the cultural and social views that are brought into the learning environment. For mathematics students, within this theory, understanding mathematics should be viewed as a personal and social-relatedness process (Anderson, 2005).

Gender Influences on Learning Mathematics

The perceptions of students who are possibly at risk of failure in mathematics are important. We need to understand what methods of teaching will reach these students. Students' perceptions, thus, their perceived ability, can profoundly affect them for the duration of their lives if left unattended. The initial issue for these students will most likely be their failure to graduate, and from there the situation will spiral resulting in lower wages, and ultimately, failure to reach their full potential.

As part of this study, gender differences in mathematics are also examined. There exists a gap in the achievement of males and females as it relates to mathematics. The reason for the gender gap among mathematics students has been the source of much debate. Theories have swirled regarding biological differences, cultural influences, the confidence-gap and more. The gap in achievement among males and females may be due to the teaching methods (Geist & King, 2008) that we are using (Becker, 2003).

In actuality, males and females may be born with similar capacities for learning and innate intellectual potential, but end up displaying differences due to sociocultural factors present in their environment as outlined in the gender-stratified hypothesis (Kane & Mertz, 2012).

The gender stratification hypothesis maintains that such gender differences are closely related to cultural variations in opportunity structures for girls and women (Else-Quest, Hyde, & Linn, 2010). Due to the fact that females are underrepresented in STEM-related career fields, much attention is being devoted to understanding gender differences in mathematics achievement and attitudes (Else-Quest et al., 2010).

The difference between males and females is more pronounced as they progress through middle school as compared to the lower-grade levels of elementary school where the differences were not as apparent. Research by Feinstein (2004) found that there are sociological and neurobiological changes that occur in male students. To that end, these changes may affect how males think and engage in the learning process (Feinstein, 2004). Additionally, such changes may account for the cognitive gender differences and their approaches to problem solving. The present study did not focus on the biological differences in males and females; instead, it analyzed the ways gender differences may influence the perceptions and motivation of students, particularly after their experience with PBL.

It is typical for students considered at risk to have negative attitudes regarding mathematics, especially if the student has not performed well previously (Goodell & Parker, 2001). Their perceptions are based on the lack of value that these students see in the mathematical concepts introduced to them. Accordingly, we need to teach these concepts in a way that emphasizes value and relevancy to the student. Our society benefits if we can establish strong mathematical

foundations for seventh-graders for the reason that, as previous research has suggested, this

transitional time spent in middle school is pivotal in terms of predicting whether a student will

dropout or graduate.

Mathematics is a powerful tool in our technologically advanced society and individuals need

to be able to demonstrate their level of understanding. This tool is the gateway to many well-

paying jobs and successful careers (Parrott, Spatig, Kusimo, Carter, & Keys, 2000).

Females need to gain the foundational skills, as well as the confidence, to succeed in STEM

disciplines, and the interventions needed may be in the teaching methods themselves. It has been

hypothesized that there are several contributing factors as to why females are underrepresented

in higher-level mathematics and mathematics related careers. Research suggests lack of interest,

lack of confidence in mathematics, genetics, cultural influences and educational methods may all

play a part (Ceci & Williams, 2010).

The Gender Gap

Progress has been made in recent years (Gibbons, 2009) as females are now equally likely to

enroll in courses such as biology, anatomy and advanced life sciences; however, females'

reluctance is still evident when we compare male-to-female enrollment in courses such as

advanced physics or computer science (National Science Foundation, 2008). Additionally, the

overall performance of females in these disciplines still trails behind their male counterparts

(National Science Foundation, 2008).

There is evidence to suggest that as early as elementary school, females begin to show a lack

of interest in mathematics and research attributes this decline to traditional pedagogy and

curriculum (Bevin, 2001). This lack of enthusiasm seems to be visible and fully manifested in middle school.

Studies have shown the need for non-gender-biased teaching methods and differentiation of instruction for males and females at the critical juncture of middle school. Research done by Reid and Roberts (2006) found that the middle-school years were particularly important in addressing gender differences related to interest and confidence in mathematics. Their research focused on the development of a program that provided a collaborative learning environment with social support for girls in the form of mentors and role models. The role models provided support by introducing career options to the girls while the mentors provided social support. Each week, the girls worked in teams to complete a research project. The research findings showed that over a 10-week span, the girls increased their skill set and benefited from the bonds formed with the mentors and role models. Reid and Roberts' research (2006) underscore the importance of the present study with their assertion, "…the middle-school years are a pivotal point for many girls and often the beginning of downward spiral of confidence and competence" (p. 300).

Research by Dentith (2008) revealed how deeply the confidence gap may affect the gender gap in STEM-related courses and career choices. One of the research questions posed in this research centered on how females describe their experiences in advanced placement science, mathematics and other rigorous classes in a highly competitive school. In this follow-up study of two high schools, incentives were given to students to take these upper-level courses. The incentives consisted of using a new formula to weigh student cumulative grade-point averages. A value of two and a half percent was added to the students' semester GPA for each AP course that

students completed. As a result, participation dramatically increased in AP courses among females and was sustained over time. The researchers wanted to find out why this incentive program was more effective in persuading female students to participate as opposed to male students. The class rankings, after enrollment in these incentive-based courses, increased dramatically for most of the participating females. The female groups largely dismissed the mere suggestion that their motive was to increase GPA or class rank.

The researchers point out that, on the surface, the overall data collected on the girls' success in school and subsequent college placement suggests that the goals of gender equity have been met; however, the research from this study indicates otherwise.

In this study, the girls, while being grouped together, were asked to answer a set of six questions. The girls were to sit in a group and in turn, in a clockwise process, answer the questions. Findings included the fact that females in this study placed a lot of emphasis on the teachers who were instructing the class. One student noted that she did not particularly like chemistry; however, she liked the teacher because the teacher related lessons to real life, and brought the concepts to life, so she agreed to take the class.

Most of the females admitted that they would have been apprehensive about participation prior to the incentive program as they were concerned about their GPA and class ranking being adversely affected. Another concern the girls had was taking a course in which they were not certain to earn an "A" at the completion of the course, which also explains their reluctance.

A recurring theme among all four female focus groups was poor self-image and diminished confidence as related to their abilities in these upper-level courses as compared to their male

counterparts. Feelings of having to work twice as hard as the males in these courses, to achieve the same results, were also expressed.

Although this study considered perceived differences among students with regard to gender, the most prominent commonality with the present study would be the quest to gain insight into student perceptions on possible sources of motivation. This study does not make a distinction between students as being considered at risk for failure in mathematics like the present study has done.

In the attempt to understand the achievement gap in mathematics and STEM-related career fields, studies have found many issues that could possibly contribute to females lagging behind males in mathematics. Kane and Mertz (2012) looked at the 2007 Trends in International Mathematics and Science Study, TIMSS, of 242 thousand eighth-grade students from 52 different countries and concluded that above such issues as national income, school type, or religion, the biggest determining factors of the achievement gap were gender equity and sociocultural factors.

However, at the individual level, the researchers posited the obvious that females who are well educated and who earn a good income are in a better position than females who lack these qualifications needed to secure their own future and to ensure, as well, that the future generation's educational needs are met.

Other studies have also found that the achievement gap between males and females in mathematics may be linked to social and economic factors. Research by the University of Missouri and the University of Leeds study (Stoet & Geary, 2013) found that girls typically do well in reading and boys in mathematics. The researchers attribute this to the overall economic

and social factors of the particular nation. This study also found that while most are trying to figure out the gender-gap in mathematics, we are ignoring the fact that the reading gap between males and females is three times larger, in favor of females.

Another interesting finding from this 75-nation study of 1.5 million 15-year-olds suggests that, in general, when economic conditions are good, the math gap increases and the reading gap decreases, and the opposite is true when conditions are bad. The researchers concluded from this that boys, as a group, respond more strongly than girls, due to biological differences in sensitivity to wider conditions. An example that this study offers is when conditions of a nation include impoverishment and violence, males tend to lag far behind females in mathematics; the opposite is true when considering wealthier nations where the social conditions are stable.

Finally, the researchers from this study warn that we should be cautious when interpreting the math gap from other countries and offer for consideration, Sweden and their gender-parity in mathematics. It is true that Sweden has done well in reducing the gender-gap in mathematics. However, these researchers ask you to also consider the fact that Swedish boys fall behind in reading scores, more so than in most other highly developed countries.

This research considered a wide range of conditions that could affect performance between males and females in reading as well as mathematics and science. The present study examined gender influences on those considered at risk of failure in mathematics

Collaborative Learning Environments

PBL is a form of experiential learning that is a collaborative instructional method and is both, interactional and student-centered (Bridges, 1992). Constructivism holds that knowledge is constructed and social constructivism holds that the emphasis is on the collaborative nature of

learning and the importance of the social and cultural context of the learning; PBL follows this

rationale. The method of PBL not only enables students to understand the material being learned

through the co-construction of knowledge, but also goes a step further, enabling a deeper

understanding of the material. Students actually learn how to learn within the PBL method. This

method is effective because it allows students to be active participants in their learning rather

than the traditional, passive, transmitting of knowledge from instructor to student (Savery &

Duffy, 1995).

   Within PBL, during the tutorial process, students are given a problem, which could have a

variety of solutions and are asked to analyze it. The PBL method calls for the teacher's role to be

altered to that of a facilitator. The teacher must now guide students through the process by asking

probing questions and guiding the students as they discover what is known and what needs to be

learned. At this point, the student must establish that which is to be explored. Relevant facts are

identified as the students analyze the problem and determine what deficiencies there are and

what needs to be learned. The areas needing exploration are known as self-directed learning

(Hmelo-Silver, 2004).

   Students considered at risk of failure in mathematics, as well as females, may be better

served by improved methods of teaching (Cerezo, 2004) such as those in collaborative settings.

There is research to suggest that instructional approaches may also play a role in the gender

differences in mathematics (Hoffmann & Haussler, 1998). Research by Werner and Denner

(2006) found that female students react positively to collaborative learning situations since it is

aligned with their social interests. Further, female students may be motivated to take a higher-

level mathematics course if their confidence and self-efficacy is raised via collaborative and

social-teaching methods; such as problem-based learning. Problem-based learning may offer the social interaction and peer acceptance female students need in order to build their confidence and motivation in mathematics. This research supports the present study regarding collaborative work environments particularly as it relates to females in mathematics.

Collaborative learning is important to the success of female students as evident in the findings of Werner and Denner (2006). Their emphasis was in understanding why females were under-represented in computer science and engineering (CSE), and what could change this status. Their study focused on implementing a culture of collaboration to increase the number of females interested in CSE. Their study involved students with "pair programming," which allowed collaboration between two partners. The students collaborate, and it was stressed to the students that there is no room for competitiveness and dominance. The findings revealed that the benefits of pair programming of performance and persistence in computer science and the collaborative environment kept female students engaged (Werner et al. 2006).

This research supports the notion held by the present study that collaborative learning may boost the confidence level of females in STEM disciplines. However, the present study will not be considering collaborative work sessions involving computers. Instead, the present study will be examining the method of teaching used for the collaborative learning sessions, which is PBL.

Peer relationships are a priority for middle-school students, particularly for females, and issues of relevancy for the concepts taught are also important. Students have a difficult time becoming engaged in the learning process when they see the material being taught as pointless. A summer camp study for middle-grade students implementing experiential learning (Weinberg, Basile, & Albright, 2012) examined student beliefs regarding STEM career professionals such as

scientists and mathematicians; through PBL activities, students gained insight into the world of scientists and mathematicians.

The researchers gave a pre- and post-questionnaire to the students to gain understanding of what the student knew regarding the job of a scientist and mathematician prior to and after the PBL experience. What researchers found initially was that student knowledge was limited in terms of what it actually meant to be a scientist or mathematician. After involvement with PBL, students' motivation and interest was greater in mathematics and students could articulate what it meant to be in these professions. In the post questionnaire, the PBL experience had made its mark on the impressionable students with regard to relevancy as students expressed sentiments such as, "It showed me that math isn't just this pointless thing, and it is used for lots of things." The perceptions of mathematics students considered at risk are useful in understanding what methods work best to teach them.

If a student believes that they are incapable of learning mathematics, they will unapologetically shut down and refuse to try to work the problems. We must find methods that motivate and empower students considered at risk. Research by Frost and Wiest, (2007) found that collaborative groups were a key component in skill development. Sixteen middle-grade students who were considered at risk of failure in mathematics were selected to participate in a summer camp designed to increase the self-efficacy of these students in mathematics through the use of experiential learning. The results of the post camp interviews showed that these students would be entering their new school year with an increased sense of self-efficacy and motivation in mathematics. Remarks by one of the campers showed the beneficial effects of the experience, "Last year I wouldn't even attempt [math]. This year I'm getting better at it. Algebra is easy."

Both of these studies looked at ways to improve the confidence of students considered at risk of failure in mathematics and their findings lend support for the present study with regards to using collaborative learning strategies such as PBL.

Similarly, another study (Cerezo, 2004) examined PBL and how "at-risk" middle-school female students perceived its effectiveness on their learning. Fourteen students participated in the study and, after their involvement with problem-based learning, the researcher conducted interviews with students to see if changes occurred in their perceptions. Students believed that PBL was effective in helping them learn mathematical concepts, and the collaborative learning situation offered in PBL helped them to better understand the concepts being taught and improved their confidence. The present study also employed the use of PBL to see if there were any changes to students' perceptions of their learning after their involvement with PBL.

Working collaboratively, students are able to deepen their understanding of concepts being taught by asking questions of those in their group (Krol, Janssen, Veenman, & Van Der Linden, 2004). Research by Snyder and Shickley (2006) found that students enjoyed working collaboratively. The present study also examined the effects of using collaborative learning environments to see if it changed the perceptions of students with regard to learning mathematics. Of the 11 students in the study, three students expressed contentment with collaborative work and said that they preferred it to working alone. Data was collected via reflective journals, learning attitude surveys and student work. The reflective journals used uniform writing prompts for all students in the study such as, "Did working in a group help, hurt or did not affect my understanding of the problem." Students were also asked to give explanations of their problem-solving techniques in their journals. The researcher relied on the

data from the grading process as well and found that many of the students in the collaborative groups experienced increases in their grades as a result of the collaborative process. This research offers support for the current study in favor of using collaborative learning environments in an attempt to boost the interest and confidence levels of student struggling with mathematics.

Another study (Lou, Shih, & Tseng, 2010) examined the impact of PBL on STEM knowledge. The participants were 10th-grade students at an all girls' senior high school. The task was to implement PBL while following the engineering design process in an attempt to design and build a solar electric trolley. Approximately 40 students on 18 teams participated. Researchers reported that the female students displayed superior math and science knowledge in the planning and design process; however, they did not do as well in the actual building process. The feedback from students regarding PBL was largely positive regarding STEM learning. Participants reported that the PBL process allowed them to explore possible career options as well as combine theory with practical application. Researchers also found that participants used higher-level thinking skills to complete the task and honed problem-solving skills in the process. In an attempt to boost interest among students, the present study will also look at students' perceptions as to the relevancy of mathematical concepts being taught. The goal will be to show these concepts in the context of a real-world problem and how the concept is used to problem solve in that situation. This research supports key points in the present study regarding relevancy in the concepts taught via PBL and the effects on motivation.

A study (Azer, 2009) by faculty at University Teknologi, Malaysia in the department of medical education research, focused on the perceptions of fifth, sixth and seventh-grade students

after involvement with PBL. This study sought to find out how students perceived PBL in middle school and how their views were affected by gender, age, or demographic factors. Findings showed that the students enjoyed the experience and thought that the PBL method enhanced their understanding of the topics and the collaborative learning situation was a benefit to their learning. Gender and other demographical factors did not play a significant role in seventh-grade student participants' views and perceptions in this study. However, one notable exception relating to gender differences came from students in fifth and sixth grade. The data showed that females believed, much more than males, that participation in this study added to their understanding. Findings from this study combined with other research findings suggest that the focus should be on how to change students' learning perspective from a passive, teacher-based situation to an active, collaborative-based situation (Boaler, 2002). These findings are for Malaysian students and may not generalize to American students in the United States. This study is similar to the present study because it looks at the perceptions of middle-grades students and their involvement in collaborative learning; however, the present study was not as broad in scope because it only considered seventh-grade students.

Another qualitative study (Samsonov, Pedersen, & Hill, 2006) entitled, "Using Problem-Based Learning Software with At-Risk Students," used observations and interviews. The data were analyzed using the content analysis method (Lincoln & Guba, 1985). Twenty-nine participants were exposed to PBL situations involving computer software called Alien Rescue. As the name implies, the students needed to rescue and find suitable homes for six species of aliens. This involved learning about the solar system and understanding the living conditions of each planet; then matching that data with the characteristics of each alien. The students who

participated met the qualifications for "at-risk" based on the following criteria: (a) poor academics, (b) serious behavioral issues, and (c) free lunch status.

The study lasted 12 days and, in their effort to complete the task, each student spent one hour per day working with the computer software. Although students were encouraged to work with a partner, some resisted citing that others would not do their part to complete the task. Some students experienced success working collaboratively; mainly students who first floundered alone and then chose a partner. Based on the findings, the researchers suggest PBL be used with students who are higher functioning academically. If students are allowed to work collectively with another student who is a higher academic achiever, then PBL may be a good fit for "at-risk" students. This study differs from the present study in that the present study did not use computer software and consisted of larger collaborative groups rather than pairs. Additionally, the present study only focused on the discipline of mathematics.

The case study (Gordon, Rogers, Comfort, Gavula, & McGee, 2001) entitled, "A Taste of Problem-Based Learning Increases Achievement of Urban Minority Middle-School Students" focused on using PBL as an enrichment activity to increase achievement and motivation among low-income, minority students. This study spanned over a two-year period and involved students from sixth, seventh, and eighth grade. Sixty-six students, both male and female, from each grade participated, forming groups of 8 to 10 students per group, totaling seven groups per grade level. While the mean average was considered for surveys completed by the staff and students, this was the only quantitative data used. Other data was in the form of interviews, which mainly focused on perceptions of PBL. No grades were recorded from assessments used in the PBL portion; however, the grades given each nine weeks for the regular courses in school for PBL participants

were compared to non-participants. The results revealed students who started in sixth grade had a significantly higher overall grade-point-average then did the non-PBL participants. The findings were not as favorable regarding grade-point-average for those who started in seventh and eighth grade, as very little difference was found. The interviews on perceptions of PBL from students were positive as well. The majority of students liked the fact that PBL used real problems and made taught concepts relevant to real situations. Additionally, the students liked the concept of being in charge of what they were learning. Behavior was also shown to improve among those in the PBL cohort; especially among those students who started in sixth grade.

This study is similar to the present study as it examined perceptions of middle-grade students after their involvement with PBL; however, it differs in terms of the scope. The present study only considered seventh-grade students as opposed to this research, which looked at the transition between sixth through eighth grade and PBL.

Cultural and Motivational Influences on STEM Learning Processes

The next section focuses on cultural influences and motivational processes included the perceived influences of confidence, interest, comfort, and anxiety. Research highlighting females holding positions in male dominated careers as well as female professionals acting as role models for younger females is cited as cultural influences. The cultural issue of stereotype threat is also discussed and its possible effects on anxiety and concentration.

Motivation and concentration.

A study by Dubetz and Wilson, (2013) shows how deeply rooted some cultural influences are and how they can affect the perceptions of female students. One goal of the researchers was to

break the stereotypical mold of the "all white male" domination of typical STEM careers in the eyes of middle-school females. The researchers encouraged females to see themselves as mathematicians and scientists. The GEMS program, Girls in Engineering Mathematics and Science, used experiential learning activities to introduce math concepts to girls, and at the same time, they also wanted to change the girls' perception of what scientists and mathematicians should look like. One informal, but effective, approach the researchers used to do this was to wear a costume closely resembling Einstein, and then asked the girls, if in their opinion, was this how a typical scientist looks. The girls typically answered "yes." Next, the researcher removed the crazy wig and lab coat to reveal a woman dressed in regular clothing. The same question was posed to the girls, "Does this look like a scientist?" and the answer was overwhelmingly, "no." The girls simply did not associate females with the role of a STEM professional. These are the attitudes and beliefs that must be renegotiated by our society. Females need to see role models in these fields that look like them to provide the motivation to pursue these types of jobs. Although the present study wants to encourage females to identify with disciplines such as mathematics and science, this is not one of the research goals of the present study. However, the two studies share the commonality of analyzing the perceptions of females with regard to mathematics.

These types of views and societal norms may well be contributing factors, and may manifest themselves in issues such as stereotype threat, which is similar to a self-fulfilling prophecy where an individual suffers debilitating anxiety over a situation in which a negative stereotype may be confirmed due to the individual's poor performance (Gilovich, Keltner, & Nisbett, 2006).

The Center for Research on Girls offers techniques and tips to educators for shielding girls from the harmful effects of stereotype threat and other issues that result in lack of motivation.

Among their tips, the Center for Research on Girls says that gender grouping is important. Research (Inzlicht & Ben-Zeev, 2003) found that concentration is reduced for females in a test-taking situation when they are out-numbered by males within the same room. To counteract this situation, teachers should seek to alter the male to female ratio in favor of females especially in testing situations. Teachers should consider splitting the class and sending females to one room to test while males go to another. If this is not feasible, then teachers could group students into smaller groups so that females are the majority in each group and the remainder of males in a separate group.

Confidence and comfort.

In the classroom, boys can be overconfident regarding their abilities in mathematics, while girls express feelings of inadequacy over their mathematical ability (Bevan, 2001). Boys tend to generalize success and mastery of one concept to being good at mathematics in general and girls are just the opposite, seeing any errors in their performance as confirmation that they are poor math students (Bevan, 2001).

Teachers may unwittingly foster stereotypes and express lower expectations to students considered at risk (Parrott, Spatig, Kusimo, Carter, & Keyes, 2000). When this is the case, the learning environment becomes stagnant for these students and difficulties in learning arise as student confidence is compromised (Johns, Schmader, & Martens, 2005).

Cultural influences also play a part in the gender gap for mathematics, and in the lack of confidence girls have toward mathematics. Research by Cornell University psychologist Ceci and Williams (2010) concluded that while there may be genetic reasons for the slight differences, culture plays a bigger part. The researchers point out that in 1983, there were 13 boys for every

girl scoring in the top 10,000 achievers for mathematics. However, by 2007, the gap had closed significantly. These statistics alone dispel the notion that the issue is genetic; otherwise, this type of improvement would not occur. The girls appear to be taking more math classes because the cultural norms that were once experienced have shifted and it is now widely acceptable to be a female in STEM-related fields. This research takes a closer look at the cultural aspect of the differences in gender and mathematics performance. However, it is similar to the present study in terms of looking at the basic influences of gender and performance in mathematics.

Confidence in mathematics among female students may also be a key to understanding why females do not pursue higher-level math courses and careers in fields that require mastery of high-level mathematical concepts. There is research to suggest that prior to middle school, interest and achievement in mathematics and science is fairly equal; however, after eighth grade, the gender gap for interest and career aspirations in fields that require high levels of mathematics becomes wider (Bae, Smith, Pratt, & National Center for Education Statistics, 1997). Janet Hyde, psychologist for the University of Wisconsin, pointed out that even though girls may get better grades, boys are still more confident in math. As researchers, to better structure interventions for girls, we need to better understand why girls lack confidence in mathematics and what teaching methods would work best to counteract this.

The confidence gap may be affected by cultural influences that females experience on a daily basis from those closest to them. Research by Lalonde, Leedy, and Runk (2003) investigated the attitudes regarding mathematics held by males and females who were participants in a regional mathematics contest. Interviews with parents, teachers and their mathematics coaches were

included in the study. The questionnaires consisted of the subscales from the *Fennema-Sherman*

Mathematics Attitude Scale (Fennema & Sherman, 1976).

One of the findings was that even in the world of talented math students the traditional

gender-based differences in the beliefs regarding mathematics were present. The responses to

questions revealed that mothers focused on the computational aspects of mathematics, while

fathers focused on the usage of mathematics and its role in science. Some of the male

participants saw test results as confirmation and evidence for the existing stereotype that males

are better at mathematics than are females. Considering this, it should come as no surprise that

they indicated that boys, fathers, parents of sons, and non-coaching mathematics teachers, held

strong beliefs that mathematics was a male domain.

Sifting through the data, the researcher found that gender-biased perceptions were prevalent

and clearly evident by two contrasting sentiments that were repeatedly expressed: First, men are

just naturally better at mathematics, and second, it is just as important for women to study

mathematics as for men. To the researchers, these two statements exemplified the inherent

conflict that women have the right to pursue mathematics even though men have more natural

talent than women.

Interestingly enough, women in this study refused to acknowledge the existence of this

stereotype. The female respondents made very fervent and unsolicited comments regarding the

actual questions. Respondents felt that the very nature of the questions was insulting to females.

The following is only two out of the many incensed comments made by female respondents, "I

thought we had progressed beyond these kinds of questions twenty years ago," and another

stated, "I found them offensive and so did my daughter." The researchers see this as a direct link

to societal attitudes, "We have been schooled to discount the presence of real gender differences in mathematics. To discuss these differences is to perpetuate a gender bias" (Leedy, Lalonde, & Runk, 2003, p. 10).

The findings for this study were discussed in an effort to resolve the conflict between students', parents', and teachers' deeply held beliefs regarding gender differences in mathematical ability and the desire for equity within mathematics education (Leedy et al., 2003). The researchers concluded that bringing awareness to these differences is a crucial step in erasing stereotypes for both sexes. These differences, the researchers suggest, should be discussed in order to take an essential first step towards educational reform. Educational strategies, this study found, need to be designed to provide equitable outcomes rather than merely equal opportunities for both genders. This is a key component in the present study as it also seeks to find equitable teaching methods for males as well as females. Our societal beliefs need to move toward seeing that gender makes us different; however, notwithstanding such, we all still possess an equivalent capacity to learn mathematics.

While our capacity with which to learn may be equivalent, how does the gender of the teacher affect student learning? Researchers (Antecol, Ozkan, & Serkan, 2013) found that the comfort level a teacher has with teaching mathematics can affect the success of their students. This inquiry-based study examined mathematics performance of sixteen 1600 students from schools in high-poverty areas ranging from Los Angeles to the Mississippi Delta region. The teachers were all well qualified, many with advanced degrees, and nearly one-third male.

The study found that females who are taught by a competent female teacher gained a significant boost in their mathematical ability and skill mastery. However, female students with a

female teacher who had anxiety regarding teaching mathematics suffered continuous declines in skill mastery. Male students' scores were unaffected by having a female teacher, irrespective of her background. Another finding was that there were no differences in math performance among male and female students of male teachers, again, regardless of the teacher's background.

Based on these findings, the question, according to the researchers, that should be posed is, "Does this mean men are naturally better math teachers than women?" The researchers believe that these findings suggest that students' gender biases can significantly impact their own ability. This study underscores the role that gender biases can play on student achievement. Positive or negative, the primary school experience may shape the future academic course of students, leading to long-term consequences like choice of study and choice of major and occupation (Antecol et al., 2013). This research lends support for the current study as to fostering positive attitudes toward mathematics in the minds of female students while blurring the perceived ability boundaries of male and female performance in mathematics.

Interest and anxiety.

Interest in a subject is crucial when learning is expected. Three factors contribute to interest; knowledge, positive emotion, and personal value (Hidi & Renninger, 2006). Anxiety also plays a role and affects interest and motivation, especially in subjects such as mathematics. A student experiencing math anxiety is unable to focus and concentrate because he or she is also dealing with feelings of inadequacy (Ashcraft & Ridley, 2005). Calculations become difficult in multi-step problems because the student's working memory is hindered (Ashcraft & Ridley, 2005).

Research suggests that math anxiety (MA) may contribute to poor performance (Devine, Fawcett, Szucs, & Dowker, 2012). These researchers found that secondary school students

experience MA; more specifically, girls experience MA at higher levels than boys, which in turn contributed to lower levels of math performance. Devine et al. (2012) made the connection between higher levels of MA and previous research that suggested high levels of MA adversely affected future mathematics endeavors (Ma X & Xu, 2004). Their goal was to measure girls' and boys' mathematics performance as well as their level of MA. The present study seeks to determine if gender influences may affect students' perceptions; however, the present study also seeks to gain insight into the perceptions of students considered at risk after their experience with PBL to determine if an alternative teaching method may aid achievement.

If gender biases can impact ability, then it is also necessary to look at issues such as interest and anxiety. Research has found common everyday expressions such as, "girls are not as good in math as boys" and other negative stereotypes tend to suppress the academic test performance of the stereotyped group (Johns, Schmader, & Martens, 2005). Stereotype threat is the name for this phenomenon in which members of the suppressed group experience difficulty in situations where their performance could confirm the basis for the stereotype. Halpern (2007) attributes this underperformance to anxiety and negative thoughts that cloud the short-term memory, thereby making it difficult to perform.

The Center for Research on Girls also maintains that there are certain things that every female should be made aware of including that idea that stereotype threat operates outside of their awareness. Certain insecurities and anxieties that female students experience may wrongly be attributed to misidentified sources other than stereotype threat. These include fear of failure even when the test is skill-level appropriate, feelings of inadequacy in mathematics, reduced working

memory, reduced performance expectations, and reduced effort. This is just a partial list of effects that may cause students to underperform.

The goals of the present study was to gain insight as to the perceptions of "at-risk" students with regard to alternative teaching methods, and to see the extent to which gender influences these perceptions. Research by Rosenthal and Crisp (2009) tested whether the application of tasks that were designed to highlight the commonalities of males and female could offset the possibility of stereotype threat. Specifically, these researchers wanted to see if tasks labeled overlap tasks would prevent the onset of stereotype threat. In this task, participants were asked to list five things that males and females have in common. In three separate experiments, conditions were given to see if stereotype threat could be prevented or made worse by certain tasks prior to testing.

The results of experiment number one found that the shared characteristics task did prevent or stunt the possibility of stereotype threat in the career choices of females. The researchers thought that this was an important finding as it suggested that the characteristics task could be the basis for stereotype intervention. Experiment number two found that with a third task of listing the differences of males and female being added to the experiment, that it is the shared characteristics task that prevents stereotype threat. This is significant because it suggests that there may be a ceiling effect, meaning when the threat is already existing, it is less likely that added conditions, such as thinking about the differences between males and females, can exacerbate the current threat. Experiment three added the kept the same conditions and added the condition of whether participants could remember the reason for the testing. Experiment three further supported the findings from experiments one and two, that the shared characteristics task

can be beneficial for reducing stereotype threat. In this experiment, a threat was activated as participants were told that their scores would be compared to the scores of male test-takers. As a note of interest, the shared characteristics task was most beneficial in preventing the emergence of stereotype threat when introduced prior to the instigation of the threat rather than after.

<div align="center">**Summary**</div>

Traditional teaching methods may not be the best fit for students who struggle in mathematics. In many classrooms, the teaching method being used is the traditional skills based model (Becker, 2003) with rote memorization of facts and teacher-centered learning. This method is inadequate in showing mathematical concepts in the context of real-world situations. Therefore, many students form negative opinions regarding mathematics (Gamoran, 2003). In order for students to see the relevancy in mathematics, they need to see that the skills they are learning are tools to solve everyday problems in the context of life.

For students considered at risk, consideration should be paid to the methods used to teach mathematics. Females are being placed at risk for failure in mathematics possibly because the traditional teaching methods in use are not meeting their developmental needs (Cerezo, 2004; Geist & King, 2008). Issues such as stereotype threat may also be adversely affecting females' performance in mathematics. This issue may be contributing to the lack of confidence that many females have regarding mathematics.

The specific causes as to why females lag behind males in mathematics has been heavily contested. Research suggests (Ceci & Williams, 2010) that the lack of self-assurance in females likely stems from the culture in which females reside. This research is validated by the findings of the Accenture survey commissioned by the Women Invent Tomorrow campaign (Costanza,

2014) who also found the gap between males and females in mathematics is based on culture and societal attitudes.

The teaching methods, just as much as cultural influences, need to be addressed in order to form a solution to the problem. There is evidence (Cerezo, 2004) to suggest that females thrive in collaborative educational environments where the educational experience is student-centered and the exchange of ideas and knowledge flow within the group.

Adding to the importance of the present study is the fact there have been very few studies that have explored students' views on PBL learning after involvement with the method (Belland, Ertmer, & Simons, 2006). This study examined gender differences in an attempt to address issues for both male and female students. The goals within PBL apply to all students: to be life-long learners, critical thinkers, and problem-solvers.

CHAPTER 3

METHODOLOGY

The proposed study sought to gain insight into the perceptions of seventh-grade PBL students. As such, this study employed a bounded-system case study design qualitative in nature. The bounded case was a PBL math class with eight students for the duration of the unit, which was three weeks. Qualitative research is difficult to define and the term with which to best describe it has even been contested. Terms such as naturalistic, interpretive, or the most popular term, qualitative, have been used for this type of research (Merriam, 2009). Regardless of the title with which this type of research is labeled, it is important to understand the meaning and characteristics of qualitative research. There are four characteristics to qualitative research (Merriam, 2009): the focus is on the process, understanding and meaning; the researcher is the primary instrument of data collection and analysis; the process is inductive; and the product is richly descriptive. The inductive characteristic of qualitative research (Merriam, 2009) necessitates that, "information from interviews, observations or documents are combined and ordered into larger themes as the researcher works from the particular to the general" (p. 16).

Denzin and Lincoln (2005) offer the definition of qualitative research as, "…a situated activity that locates the observer in the world" (p. 3). The social environment, and the understandings that people have regarding the phenomena occurring in that environment, is an essential part of qualitative research. In other words (Denzin & Lincoln, 2003), "qualitative researchers study things in their natural settings, attempting to make sense of, or interpret phenomena in terms of the meanings people bring to them" (p. 3).

Conceptual Framework

Maxwell (2005) describes the theoretical framework, or the scaffolding, which frames the study as, "…the system of concepts assumptions, expectations, beliefs and theories that support and informs your research" (p. 33). Sociocultural theoretical perspective, which frames the current study, is based on the notion that we co-construct learning through social interaction. This theory suggests that we learn from the culture we live in, which includes the influences of our parents, caregivers, teachers, peers, and other cultural sources.

Research Questions

The focus of this research was to explore the perceptions of seventh-grade students considered at risk of failure in mathematics. It is imperative that we understand which teaching methods will be effective with students, especially those who struggle with mathematics; therefore, it is important that we delve into students' perceptions regarding an effective teaching strategy for mathematics. If we can find teaching methods that students themselves believe are useful for their learning, we may be able to motivate them. A successful teaching method could possibly improve the learning of marginalized students, both male and female, who have been placed at risk in traditional mathematics classes. Stepping away from traditional methods and toward strategies such as PBL may also aid in students achieving a deeper understanding of mathematical concepts.

Research Questions:

1. A. In what ways do "at-risk" seventh-grade female students who have been involved in PBL math classes perceive changes in their learning processes?

B. In what ways do "at-risk" seventh-grade male students who have been involved in PBL math classes perceive changes in their learning processes?

2. A. In what ways do "at-risk" seventh-grade female students who have been involved in PBL math classes perceive changes in their motivational processes (e.g., confidence, interest, anxiety)?

   B. In what ways do "at-risk" seventh-grade male students who have been involved in PBL math classes perceive changes in their motivational processes (e.g., confidence, interest, anxiety)?

3. In what ways do gender differences influence the perceptions of learning and motivational processes by "at-risk" seventh-grade students who have been involved in PBL math classes?

Methods

Research Design

   Merriam (2009) asserts that the single most defining characteristic of a case study is the delineating of the object of study, the case. A case, according to Stake (2006), is "…a noun, a thing, an entity; it is seldom a verb, participle, a functioning" (p. 1). It is the functioning of the case that we hope to examine, not the case itself. We may want to examine, "managing, becoming effective, giving birth" (Stake, 2006, p. 1). However, these examples of the functioning of the case are not the case itself. The cases are, "…managers, production sites, labor

and delivery rooms…with these cases, we find opportunities to examine functioning, but the functioning is not the case" (Stake, 2006, p. 1).

Similarly, this research endeavors to understand the perceptions of seventh-grade students after involvement with problem-based learning. Within this case study, the students are the case and the functioning of these students, their perceptions, is the center of our research. And, this research is a bounded-system as it is, "…a single entity, a unit around which there are boundaries" (Merriam, 2009, p. 40). The boundedness of the case topic can be assessed by asking if the data to be collected is infinite. If this happens to be the true, then it is not a bounded case study. There should be a limit to the number of people who can be interviewed or a finite time for observations. "If there is no end, actually or theoretically, to the number of people who could be interviewed, or to observations that could be conducted, then the phenomenon is not bounded enough to qualify" (Merriam, 2009, p. 41).

Merriam (1998) defines case studies as qualitative research focused on discovery, insight, and understanding from the personal perspectives of those being studied. In a case study, the researcher approaches a problem of practice from a holistic perspective; thus, gaining an in-depth understanding of the situation, and further, finding its meaning for those involved. This technique results in the interest being in the process, rather than in the outcomes—in context and in discovery, rather than in a specific variable or confirmation. Obtaining an in-depth understanding of student learning may prove to be useful for practice, educational policy, and future research. A great advantage to this type of approach is the close association between the researcher and the participant that enables participants to tell their stories (Crabtree & Miller, 1999). Bromley (1986) builds on this notion by stating that case studies, "…get as close to the

subject as they possibly can, partly by means of direct observation in natural settings, partly by their access to the subjective factors (thoughts, feelings, desires)…" (p. 23).

There are many advantages to the case study design including gaining insights which serve as tentative hypotheses to help structure future research and further the knowledge base in that particular field (Merriam, 2009). However, the issue of generalizability limits this type of qualitative research more so than others because case studies focus on a single unit or a single instance. In defense of this design, Merriam (2009) points out that the strengths of the case study design far outweigh the limitations. A "…vivid portrait of excellent teaching" could be used as an exemplar for teacher education (Eisner, 1991, p.199). There are many individual applications for the findings in case study research, and, as such, "it is the reader, not the researcher, who determines what can apply to his or her context" (Merriam, 2009, p. 51). For qualitative researchers, the interest lies in how people interpret their experiences, and what meaning they attribute to their experiences (Merriam, 2009).

Research Setting

Tatum Middle School (anonymous name) is situated in a small rural community west of Augusta, Georgia. This Title I school, where 57% of the students qualify for free or reduced lunch, is the smallest in the county in which it is located. Tatum serves a total of 544 students spread over grade-levels sixth, seventh and eighth. Thirty-three certified teachers serve the three grade levels at Tatum. In addition to those 33 teachers, there are two math coaches and one language arts coach on staff. Tatum has one media specialist and one media specialist assistant; additionally, there are two guidance counselors.

Among several other accolades, this school has also earned a five-star rating on the College and Career Ready Performance Index (CCRPI). Every teacher in this school has earned the Gifted Endorsement and is certified to teach these classes. The school creed advocates the idea that everyone can learn and every day is another opportunity to prove it. Regular attendance is stressed to the students because the administration believes that there is more than just the obvious correlation between attendance and achievement. Students are celebrated for perfect attendance each nine-week period in an attempt to keep them motivated and regularly attending school. The intentions of these activities are good and partially successful; however, there are still attendance issues.

The ethnicity and gender composition for this school is as follows: 249 male students and 295 female students. The racial composition of Tatum is as follows: 406 White (75%), 77 African-American (14%), 34 Hispanic/Latino (6%), 25 mixed-races (5%), 1 student is Native American (.2%), 1 student is Asian (.2%).

This research examined the perceptions of students considered at risk for failure in mathematics, and as such, I chose a Title I school. Tatum Middle School is a Title I school and serves a large population of students who lack familial support and live below the poverty level. Many of the students in Tatum Middle School struggle in mathematics and many also struggle in reading comprehension. There is a great need at this school to find teaching methods that will motivate and empower these students. Education is a vehicle for these children to break the cycle of poverty and effective teaching methods are imperative to make this a reality. For this reason, I choose a Title I school. I have worked at this school for the past six years and understand the stories behind many of the families that we serve. I feel that I have an added benefit in knowing

the background of many of the students in this school as I have taught many of the siblings of these students.

Participants

Sampling for a case study involves selecting the studied unit. For probability sampling, the researcher randomly selects units of study for analysis and then generalizes the results obtained from the sample population to the population from which it was drawn (Merriam, 2009). However, for non-probability sampling, the unit of analysis is chosen based on the judgment of the researcher. Hence, this sampling technique is often referred to as judgmental selective or subjective sampling (Patton, 2002).

Non-probability approaches are more appropriate for in-depth qualitative research in which the focus is often to understand complex social phenomena (Small, 2009). Non-probability sampling is the most common choice for qualitative research and, "the most common form of which is called purposive or purposeful" (Patton, 2002).

Purposive sampling, a non-probability sampling technique, was used for participant selection in this case study. To employ this type of sampling, criteria must be set to guide case selection. With this approach, the selection of participants is criterion-based (Mason, 2002). The participants were selected based on meeting the set criteria, which will thereby provide insight into the research questions. Purposive sampling is exactly what the name suggests; participants are deliberately selected on "purpose" to represent key criteria (Ritchie & Lewis, 2003).

Eight students from the seventh-grade considered at risk because of past failure in mathematics were asked to join the case study. The goal was to have a balance of males to females and a range of races as participants in this case study. The specific criteria used for

inclusion in the study were: (a) seventh-grade student, (b) at risk of failing mathematics for the school year, (c) previous record of failure in mathematics in terms of grade averages, and (d) failure on previous mathematics standardized tests. Table two gives student history for study participants.

Table 2

Description of Student Participants

Name	Gender	Grade	Race	Math GPA History	Math STD. Test History	Current Math GPA
Patrick	Male	7th	Caucasian	65–75	700–750	< 70
Quantavious	Male	7th	African-American	70–80	700–750	75
Drake	Male	7th	Spanish	75–85	750–800	79
Marcus	Male	7th	Caucasian	65–75	700–750	< 70
Crista	Female	7th	Caucasian	70–80	750–800	75
Monique	Female	7th	Asian Indian	75–85	750–800	78
Dana	Female	7th	African-American	65–75	700–750	< 70
Alison	Female	7th	Caucasian	65–75	700–750	<70

Procedures

   Prior to the start of the study, participation guidelines were explained to study participants,
including the fact that no consequences would result from their withdrawal from the study. All
observations and interviews were conducted in accordance with an agreed upon time between the
principal of Tatum Middle School and the researcher. At the beginning of each interview, the
researcher reminded the respondent that their participation was strictly voluntary. Additionally,

every respondent was informed that they have the right to discontinue the interview at any time and they had the right to ask questions.

Research Procedures and policies set forth by the Georgia Southern University Review Board (IRB), as well as the Columbia County Board of Education (CCBOE), were respected and fulfilled as this research progressed. The local school board (CCBOE) was contacted and permission was obtained to perform the proposed study; which included a letter of authorization from the principal of Tatum Middle School. After approval of the prospectus, approval was obtained from Georgia Southern University Institutional Review Board.

Instructional Case

The PBL curriculum unit was conducted over the course of three weeks with several of the problems used coming from the PBL library at Wake Forest University. The researcher completed all requirements for CERTL certification for PBL at Wake Forest University, and therefore, had full access to the PBL library and other resources at Wake Forest. All PBL problems were grade-level appropriate and pertained to mathematics.

In the following, I describe the general protocol that was followed for each PBL session. The PBL process began by placing students in groups of three. There were a total of 18 students in the class; however, only eight were study participants. The grouping strategy used for forming groups included consideration of personalities involved as well as possible discipline issues based on previous class experiences. With those issues in mind, the researcher tried to group students with similar skill levels together for most PBL problems. Sometimes the groups were formed with group members with varying levels of ability so that students with a stronger knowledge base with a particular concept could help those students who were struggling. Next,

each group was given a PBL prompt that outlined a scenario. The prompt gave a few details, but not enough to solve the problem. Then, students were encouraged to form two lists, one list of things already known from the information given, and then another list of things that the group would like to know. Once the list of things that the group would like to know was completed, the group members were encouraged to create follow-up questions to get answers. Then, the class came together in a whole-group discussion to narrow down the question lists and remove needless questions.

At this point, there was one main list of questions for which each group was trying to gain answers. Next, the groups started their research or they asked the teacher questions. Some PBL problems had a lot of supporting facts for the scenario while other PBL problems required the students to do research. When research was required, the PBL problem usually provided Internet resources to point the student in the right direction.

Finally, students examined the information that had been discovered in an attempt to formulate a plausible solution for the scenario. At this point, there was usually a good deal of discussion among group members to arrive at the final solution that the group would present. Once an agreement was reached as to the solution, the group then decides how the data would be presented, and who would represent the group during the presentation.

The mathematics concepts covered in the PBL units included geometry standards, and standards in inferences. From the geometry portion, concepts such as surface area, volume, circumference of a circle and angles and their measures were included. The inferences concepts that were covered included generalizations about a population from a sample, interpretation of

statistical data, and measure of center and estimation. The actual PBL prompts and supporting documents can be found in Appendix D.

A typical PBL prompt gave students enough information for them to start formulating ideas regarding possible solutions but not enough to finish. As the students started to think about the problem, they also realized that there were things that they would like to know, and they were encouraged to ask questions to gain this information.

In the case of the Snow problem, students were given a PBL prompt, which consisted of a picture of a car that had a block of snow on top of its roof. The students were asked what they noticed about the picture of the snow on the roof of the car. Conversations began in the groups as students started asking questions about what type of vehicle was pictured and the possible estimation of the dimensions of the roof. Eventually, discussions led to volume and surface area of the block of snow. As the students started to formulate the possible answers, someone noticed that the snow looked compact. This prompted students to ask if the snow was fluffy or dense. When this question was asked, I was able to supply the students with an information sheet regarding density of the snow so that students could make certain inferences regarding the snow in addition to the volume and surface area of the block of snow.

The detailed curriculum content covered in the three week PBL unit consisted of the following standards and objectives.

Geometry standards

- MGSE7.G.2: Explore various geometric shapes with given conditions. Focus on creating triangles from three measures of angles and/or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

- MGSE7.G.3: Describe the two-dimensional figures (cross sections) that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms, right rectangular pyramids, cones, cylinders, and spheres.

- MGSE7.G.4: Given the formulas for the area and circumference of a circle, use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.

- MGSE7.G.6: Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

Inference standards

- MGSE7.SP.1: Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.

- MGSE7.SP.2: Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be. Draw informal comparative inferences about two populations.

- MGSE7.SP.3: Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the medians by expressing it as a multiple of the interquartile range.

- MGSE7.SP.4: Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.

Objectives for geometry standards
- Use freehand, ruler, protractor and technology to draw geometric shapes with give conditions (7.G2).

- Construct triangles from 3 measures of angles or sides (7.G2).

- Given conditions, determine what and how many type(s) of triangles are possible to construct (7.G3).

- Describe the two-dimensional figures that result from slicing three-dimensional figures (7.G4).

- Identify and describe supplementary, complementary, vertical, and adjacent angles (7.G4).

- Solve mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms (7.G.6).

Objectives for inference standards

- Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population.

- Understand that random sampling tends to produce representative samples and support valid inferences.

- Use data from a random sample to draw inferences about a population with an unknown characteristic of interest.

- Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.

- Informally assess the degree of visual overlap of two numerical data distributions with similar variability, measuring the difference between the centers by expressing it as a multiple of a measure of variability.

- Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.

Data Collection

Typically, the most commonly used sources of data in qualitative research include interviews, observations, and documents (Creswell, 2009). For the purposes of this study, data was collected in the forms of interviews, field notes, student work samples and reflective journals in an attempt to obtain a rich, thick description of the data (Merriam, 2009). Credibility of the data was established through the triangulation of multiple data sources (Merriam, 2009). Cross-checking and comparing data in this way strengthens the validity of the findings (Wolcott, 2009). Varied sources of data are one of the strengths of data collection in case studies (Yin, 2009).

Individual, 45-minute semi-structured interviews were conducted with each student in the school media center two days after completion of the PBL unit. Table three summarizes the information needed and the methods by which the information was obtained.

Table 3

Data and Methods Needed to Address Research Questions

Research Questions	Information Needed	Method of Inquiry
1. In what ways do "at-risk" seventh-grade students who have been involved in PBL math classes perceive changes in their learning processes?	Student participants' perceptions of their learning after PBL experience.	Observation Interview Journal and field notes
2. In what ways do "at-risk" seventh-grade students who have been involved in PBL math classes perceive changes in their motivational processes (e.g., confidence, interest)?	Student participants' perceptions of their motivation after PBL experience.	Observation Interview Journal and field notes
3. In what ways do gender differences influence the perceptions of learning and motivational processes by "at-risk" seventh-grade students who have been involved in PBL math classes?	Perceived differences among students, based on gender, of their learning and motivation after PBL experience.	Observation Interview Journal and field notes

Sources of Data

The primary source of data for this qualitative study was obtained through interviews.

Additionally, the researcher fully disclosed the fact that she was in the process of doing research

and acted as a participant observer during class session observations. Therefore, the second source for data was gained through observations (Appendix A, Observation Protocol), which were recorded in field notes and reflective journals. Also, the teacher collected samples of the students' classroom work.

Interviews

The importance of the interview process is underscored by the fact that hopes, desires or feelings cannot be observed, but they can be expressed in interviews (Merriam, 2009). The primary source of data for this study was acquired through semi-structured interviews with open-ended questions to guide the interview (Appendix A). The nature of a semi-structured interview allows the researcher the freedom to ask follow-up questions when triggered by respondent's answers to initial questions. The climate of the interview process for this study was (Merriam, 1998), "respectful, nonjudgmental, and nonthreatening" (p. 85). These face-to-face meetings took place in the school media center and lasted approximately forty minutes each.

Every interview began with the researcher outlining, for the benefit of the participants, a clarification and an understanding of five key issues (Taylor & Bogdan, 1984).

1. The motives and intentions of the researcher and the inquiry's purpose.

2. The respondents' names shall be protected, as each name used will be a pseudonym for each respondent.

3. It will be explained who has final say over the study's content.

4. They will not be paid for their involvement.

5. If any follow-up questions arise, when and where those follow-up interviews shall take
   place.

A pilot interview was conducted prior to the start of the study to ensure efficiency of the
interview and to make any adjustments to the question list. The quality of the interview questions
is imperative and, as such, the researcher has carefully crafted and/or chosen the questions in an
attempt to gain the most from each interview. Merriam (2009) asserts, "Good questions are at the
heart of interviewing, and to collect meaningful data a researcher must ask good questions."

The interviews were semi-structured and most of the questions were open-ended, giving
latitude to the respondents when answering questions (Appendix B). Six types of questions are
recommended (Patton, 2002) and each question fits into one of the categories described in the
next paragraph.

After the obligatory category of demographical questions for obvious reasons, the researcher
must move into the questions which will help shed light on the situation. The first suggested
question category by Patton (2002) is experience and behavior questions, which reflect the
respondent's actions, behaviors or history. The next type of question Patton (2002) suggests is
the opinion and value questions in which the researcher probes for the beliefs and opinions of the
participant. Feeling questions (Patton, 2002) are those questions in which the researcher "is
looking for the respondent to reply with adjective responses such as anxious, afraid, happy,
intimidated, confidant and so on" (p. 350). Knowledge question are just as the name implies,
those questions in which the respondent is asked to give their factual knowledge regarding the

situation. Finally, sensory questions are probably the most pertinent to PBL as these questions ask the respondent to explain what was experienced, seen, touched or heard (Patton, 2002).

Observations

Observations allowed the researcher to see firsthand how students are interacting with each other and responding to the PBL learning. The researcher fulfilled the role of facilitator in the PBL process and acted in the capacity of participant-observer for the study. Merriam (1998) warns that the mere presence of the researcher may create an artificial environment where observations are created or partially influenced by the presence of the researcher (Yin, 1994). However, irrespective of why the events occur, it is still valuable for the researcher to view behaviors and specifics in context of the situation (Yin, 1994).

The key to quality observations, as Patton (2002) points out, is to pay attention, write descriptively, record quality field notes and know the difference between detail and trivia. Observations are valuable for a number of reasons; first of which, as noted by Merriam (2009), is the fact that they provide some context of the situation and some specific behaviors or reference points that can serve as support for subsequent interviews. Observations can also provide information or shed light on topics that participants are not readily willing to talk about in an interview (Merriam, 2009).

Observations were conducted throughout the duration of the study and an observation protocol was followed. As outlined in the observation protocol, formal observations were conducted on March 10th, 16th, and 23rd of 2016. I also made notes contemporaneously during

PBL sessions in a journal. In my observations, I paid close attention to whether or not gender differences existed in the motivation and confidence of students during PBL sessions.

Student work samples

Collected samples of student work were used to provide essential data to the researcher to assess student understanding. Student work samples can also provide insight as to the level at which each student is currently performing and to assess if any growth has occurred in student comprehension for specific mathematical concepts. Specifically, I wanted to see if students perceived any changes to their learning processes and if gender differences played any part in these differences.

Student work samples were also used as a comparison of previous work and current work to determine if motivation processes such as confidence, interest and anxiety have increased or decreased as a result of their experience with PBL.

Data Analysis

Merriam (2009) asserts that, "data analysis is a complex process that involves moving back and forth between inductive and deductive reasoning, between description and interpretation" (p. 176). The constant comparative method of data analysis will be used for the present study. With this type of data analysis, there is a constant comparison of the data to the same data set and other data sets (Merriam, 2009). The use of coding is common in the constant comparative method of data analysis. Coding is the way in which you define what the data you are analyzing are about (Gibbs, 2007).

As data is examined and compared to other data, trends begin to develop during these comparisons and categories emerge (Merriam, 2009). When a theme develops, it is an outcome of coding, categorization, and analytic reflection, not something that is, in itself, coded (Saldana, 2013).

Data analysis began with the onset of data collection as recommended (Merriam, 2009) for case study analysis. All interviews, field notes and reflective journal entries were coded and transcribed, and then files were created for organizational purposes as the data was acquired. As the data was analyzed, the researcher was vigilant in looking for thematic trends as a result of the use of coding.

Limitations and Delimitations

The boundaries of this study include the fact that the pool of study participants from which participants were drawn included one specific school, Tatum Middle School, and from one particular grade level, seventh grade. The pool of candidates consisted only of those students who meet the set criteria for being considered at risk. Additionally, the content for the study was delimited to mathematics for seventh-grade students.

The sample size was small; therefore, generalizability was limited. The word "generalizability' is defined as the degree to which the findings can be extended from the study sample to the entire population (Polit & Hungler, 1991). However, according to Adelman, Jenkins, and Kemmis (1983), the knowledge generated by qualitative research is important in its own right. The qualitative research of a case study provides a rich in-depth understanding of the case under study and may provide suggestive implications for similar cases. Another limitation

of this study is social desirability (Lavrakas, 2008). In other words, students may give the researcher pleasing (socially desirable) answers because the researcher is also their teacher who grades them.

Assumptions

More effective methods of teaching need to be explored if we are to aid those who are not being served by current inequitable teaching methods. In an attempt to explore the perceived effectiveness of PBL, it is assumed that students selected for the study performed to the best of their ability, and they understood and responded willingly and honestly to the interview questions. Also, it was assumed that the participants understood the PBL process, and in turn, the participants were able to articulate reliable and useful feedback about their experience. Another assumption was that the participants were capable and self-disciplined enough to perform to the best of their ability.

Summary

The purpose of this study was to investigate the perceptions of "at-risk" mathematics students regarding their involvement with PBL. This chapter discussed the research methodology, which was used to carry out this study. Eight students who fit the set criteria of being seventh-graders considered at risk of failure in mathematics participated in the study. The specifics of the criteria as well as the research design, data collection methods, data analysis and procedures are described in detail in this chapter.

CHAPTER 4

FINDINGS

The purpose of this study was to gain a deeper understanding of the perceptions of historically low-performing seventh-grade mathematics students after their experience with an experiential teaching method known as problem-based learning (PBL). Additionally, gender differences were examined to determine if female students perceived their PBL experience in mathematics differently than male students. This was done by enabling students to experience PBL applied to a unit of mathematics during which observations were conducted for gender differences (see Observation Protocol, Appendix A). Following the PBL unit, students were interviewed using a list of semi-structured questions (see Student Interview Questions, Appendix B). Contemporaneous notes were recorded in a teacher journal during the PBL unit, which provided opportunities to triangulate the data between interviews, observations and journal entries.

This study—conducted in a Title I middle school in rural central Georgia—consisted of eight students. The students' verbal responses from the interviews were recorded during the interviews and then transcribed. The transcribed student responses were coded and categorized in order to detect common themes and patterns in the data. Once the common patterns emerged, the data was then compared to the classroom observations and field notes.

Figure 1: Outline of Seventh-Grade Students' Responses to Research Questions

I.   Perceived Changes in Learning and Motivation

    A.   Perceptions of learning prior to and after PBL
        1.   Perceptions of male students prior to PBL
        2.   Perceptions of female students prior to PBL
        3.   Perceptions of male students after PBL
        4.   Perceptions of female students after PBL
        5.   Similarities and differences in PBL and traditional methods
    B.   Perceived changes in motivation, interest, confidence, comfort, anxiety and concentration after PBL
        1.   Perceived changes in motivation and concentration in male students.
        2.   Perceived changes in motivation and concentration in female students
        3.   Perceived changes in confidence and comfort in male students
        4.   Perceived changes in confidence and comfort in female students
        5.   Perceived changes in interest and anxiety in male students
        6.   Perceived changes in interest and anxiety in female students

II. Gender Differences and Influence on Perceptions of Learning and Motivation

    A.   Student perceptions and observations of gender differences
        1.   Male perceptions of gender differences
        2.   Female perceptions of gender differences
        3.   Researcher observations

III. Perceptions on Grouping and Gender Differences

    A.   Students' preferences on grouping
        1.   Mixed gender verses same gender grouping
        2.   Why grouping preferences matter
        3.   How gender affects the group dynamic

The figure one outline provides the basis for how the data is presented. The outline of the findings is organized by the research questions. The findings have been analyzed to ensure proper placement and categorization of data. This classification of data enables it to be presented

in an organized fashion. For each section of the outline, common themes are identified, discussed and supported by relevant excerpts from the student interviews. These excerpts provide self-reported descriptions of students' perceptions germane to understanding the study from the students' perspectives.

I. Perceived Changes in Learning and Motivation.

Section A and the questions addressed within it relate to research question number one, which asks, "In what ways do "at-risk" seventh-grade students who have been involved with PBL math classes perceive changes in their learning processes." During the student interviews, the first two questions that students were asked pertained to their previous experience in mathematics class and their perceptions regarding math after their PBL experience. The student responses to interview questions pertaining to perceived changes in learning are discussed in this section. Following this section, section B addresses research question two regarding perceived changes in the students' motivational processes.

A. Perceptions of Learning Prior to and After PBL

1.   Perceptions of males regarding math prior to PBL.

Many students hold the misguided belief that mathematical ability is inherent (Deweck, 2006). Given that misunderstanding, it is easier to appreciate the student responses regarding previous math classes.

Listed below are some common thematic student responses to the following question, "Before taking the problem-based learning class, how well did you do in math classes?" The thematic

response by male students for this question was a negative prior perception of math. They reported that previously math was too difficult and they performed poorly. Three of the four male study participants expressed negative feelings regarding previous math classes.

> Drake: "They went a little too fast for me and I couldn't really catch on."
>
> Patrick: "Not well, I had C's sometimes D's in math. It was hard. It took a lot of time to answer a problem and was kind of boring."
>
> Marcus: "In other math classes, I wasn't doing too well."

For struggling math students, isolation can be a factor as they feel as though they cannot get the answer by themselves, and there is no one else to help them. I have observed in my math classes that students who are considered at risk are sometimes even embarrassed to admit to the teacher that they do not understand certain concepts. This is especially true when the concepts are below grade level, such as multiplication facts in seventh grade. This is where working in a group, which is not typically done in a traditional setting, really aids these students who cannot find the solution to a problem without extra help. The group work aspect of PBL is a natural fit with the sociocultural theoretical perspective because it states social interaction is fundamental in the process of cognitive development, and for struggling students, social interaction is often very helpful.

Math anxiety may also contribute to male students' negative prior perceptions regarding mathematics. Research by Devine, Faucette, Szucs, and Douke (2012) found that anxiety regarding performance in math class affected students' perceptions of their ability in mathematics. Based on students' responses in the present study, it appears that male participants harbored anxiety related to past math performance.

2. Perceptions of females regarding math prior to PBL.

Female students shared the perceptions of male students. The females' thematic response to prior math was a negative perception similar to the males' response. Most of them reported that math had always been a struggle citing lack of comprehension of concepts and the inability to retain the skills once a new concept was introduced. Allison explains that the teachers would not present and teach concepts on her level and, therefore, it was difficult for her to grasp some concepts. When asked about math classes prior to PBL, Allison points out that she did not feel supported and could not reach out for help from other students or from the teacher. Two of the four female study participants stated that prior math class experiences were negative.

> Allison: "Bad. I didn't have much help. The teachers would call on us and we didn't know the answer or it was hard for them to explain it to us in a different way."

> Monique: "I've never really liked math classes because like math is very hard for me so I don't usually enjoy it because it comes hard to me. I did bad in math classes before because I had distractions. And some teachers, they would have only one way, like one method they would use for all of their students, and I really didn't like that because we don't all learn the same way."

Research by Reid and Roberts (2006) found that middle school was a pivotal point for female students. They found that there was a tendency toward a downward spiral of interest and motivation levels in disciplines such as mathematics for females during the middle-school years.

There were points at which some of the female students expressed positive experiences in previous math classes and gave examples of why traditional teaching methods worked for them. However, three of the four female students also revealed concern regarding the competitive aspect of traditional teaching methods and how this negatively influenced their performance in previous math classes.

> Allison: "Because like you have the answer but the other kid heard you say it or like they know and they shout it out just so they can like tell people that they're smart too, or something."
>
> Dana: "Other people were trying to like get the answer; say they are better, like prove or show off."
>
> Monique: "So they'll either try to one-up each other like, okay, I know this and you don't or you're not very strong in that suit."

During my observation, I noticed that the competitive theme within the learning environment was a real issue for several students, especially the females. This was partially due to the fact that they had already figured out that they were placed in a lower performing class. For these students, the realization of being in a class with low performers, coupled with their low sense of accomplishment and ability in mathematics, made it difficult for them to even admit to me, their teacher, when they did not understand. It appeared they felt that if they admitted to not knowing it would further prove they actually belonged in the low-performing class. The competitive aspect exacerbated this issue, as it further publicly proved who was "smart" and who was not by forming a ranking of intelligence within the class.

Research by Werner and Denner (2006) found that the females performed better in academic settings where issues such as dominance and competitiveness displayed by other students were nearly undetectable. Their findings are consistent with the present study.

3. Perceptions of male students after PBL.

Next students were asked about their perceptions of PBL after the actual PBL unit was taught. The goal was to have students provide insight as to whether PBL was an effective learning method for them and if it should be considered as a viable alternative for future use. The following question was posed, "After using PBL, what do you think about it? Do you think PBL has improved your ability to solve math problems?" Each of the four male participants in the study expressed a common thematic response of positive feelings regarding their PBL experience. Also all four male study participants cited the group aspect as being very helpful in working out the PBL problems.

The males' thematic response to the PBL unit experience was a positive perception of PBL. Two of the four male study participants cited the fact that they received validation of their ideas from other students. The other two male study participants expressed positive feelings due to the freedom allowed to solve the problem.

> Drake: "Before PBL's my teachers used to—they would give you the problem,
>
> you have   to solve it, and you go to the next problem. But with PBL, it is
>
> easier because you get time to work the problem out and it's a single
>
> problem and not a sheet full of problems. And you have other people to
>
> help you with it and it's just easier because of the real world application."

Quantavious: "The traditional teaching method is basically like the teacher is

giving you instruction and then they're going to basically help you with

that if you don't understand. But with PBL, you're in a group—it's

different because you have other people to help you solve it with you."

Marcus: "I thought it was a good bit easier because I could actually hear other

people's opinions on my answer and change according to what they

thought of it."

Patrick: "Made me think. And like you had to make two separate lists of what you

knew and what you needed to know and then you had to answer the

questions. We got to do a lot more by ourselves. Like it wasn't a lot of

listening. We did a lot of writing and thinking. It was hard."

Most of the students seemed to favor the PBL method as opposed to the traditional, teacher-centered method. This finding is not surprising because the students in this study had suffered years of struggling and even failure in previous mathematics classes.

Research by Frost and Weist (2007) suggested that collaborative groups were a key component to skill development. These researchers also found that collaborative grouping builds self-esteem with struggling math students because these students are able to gain validation of ideas from other group members. These findings were consistent for both males and females in the present study.

4. Perceptions of females after PBL.

The female students in the study unanimously liked the group work aspect of PBL. I observed that most females were comforted by the fact that they could work with others to find solutions

to the PBL questions. The females' thematic response to perceptions of PBL was similar to those of the male participant, which was very positive. Two of the four female study participants cited the ability to work with group members as one of the best aspects of PBL.

> Allison: "I liked it. We got to talk to other people and it helped because the teachers could not explain it the way other students could. It was better than the usual lame math problem."

> Monique: "Some teachers were like, I'm just telling you this is how you do it, that's how you are supposed to do it, like you didn't get another option. PBL was easier because I could rely on other people. It was a group thing. And then I could show my strengths in certain areas, so I liked that method [PBL] better."

> Crista: "It was hard at first and then it got easier after you explained it and we got into it."

Another point that was mentioned often was the fact that there is more than one way to solve a problem. This was not a new revelation for the students; however, I think there was an emphasis placed on this concept of multiple ways to solve a problem with PBL. Similar to the males' response, the females also liked being able to gain validation of their ideas from classmates. Research by Frost and Weist (2007), which found that females thrive in a supportive, collaborative educational setting, is consistent with findings from the present study.

5. Similarities and differences between PBL and traditional instruction.

The next set of questions aimed at comparing previous methods of teaching mathematics with PBL. When asked, during the tutorial phase of this study, none of the study participants recalled

learning with methods other than traditional teaching methods in which whole group, teacher-centered instruction, was the main delivery method. The next interview question was, "How did the PBL method compare to other methods of learning math that other teachers have used in the past with you?" It became apparent to me, when I reflect back on my students' answers to these interview questions, that students really liked to find their own method of solving a problem and, from their perspective, that made the most sense to them rather than having a teacher tell them how they must solve it. Several students, like Monique and Allison, cited this reason for offering their endorsement of PBL.

> Monique: "Well some teachers, they would only have like one method they would
>
> use for all of their students and I didn't really like those kinds of things
>
> because we don't all lean the same way. Somebody may take steps out and
>
> other people might add steps so that they understand."
>
> Allison: "There was more people to talk to and there were different ways to solve
>
> it and different ways to learn about it."

This reoccurring theme of freedom of choice in the how to solve a problem, that emerged during the data analysis phase of this study had not occurred to me prior to this study. I do not recall in my regular math classes students voicing concerns regarding the freedom to choose an alternative learning method to solve a problem. I believe that I have always been open to allowing alternative methods as long as I could logically follow their chosen method. However, the student, Drake, made a point deeper than just the teacher's expectation of the method to be used. This student believed that even the authors of the textbooks steered students toward a particular method of problem solving.

Drake: "Like a regular math problem is usually, the first part is already solved for

you and set up in a way that they want you to solve it. But with PBL, you

can find that way that you want to solve it, in your own way. When I only

have one way to solve the problem, it makes me feel contained into one

way other than having more ways to go."

Drake was expressing what he saw as yet another difference between PBL and traditional

teaching methods. For him, even the PBL prompt was a welcomed change. Drake did not like the

way that traditional math problems directed students into a specific method to be used to solve

the problem. Drake liked the fact that he could approach the PBL from any angle he chose as

long as he could explain his approach to the group.

Research by Cerezo (2004) and Snyder and Shickley (2006) both found that the collaborative

aspect of working in groups was well liked by study participants. Most of the students

interviewed in the present study agreed that the group work aspect of PBL was beneficial and

found it to be one of the best elements of PBL. Several of the students also listed the group

aspect as a similarity to traditional teaching methods with certain caveats. These students pointed

out that with traditional teaching methods, teachers are selective about which lessons will lend

themselves to working in groups, whereas with PBL, group work is a constant. I will address the

points on group work later.

As to differences between PBL and traditional teaching methods, the results varied, so I will

only highlight the main differences that students cited. Several of the students said that the

biggest difference between traditional teaching methods and PBL was the amount of latitude

students experience when solving a problem. The general consensus was that students really

liked to figure out the best way to solve a problem. Some of the students liked minimal assistance and then confirmation from the teacher about whether their answer was correct or not, and then to receive informal feedback on mistakes made. I observed this firsthand when a student asked me to look over her work. I saw her mistakes and she insisted that she be able to re-work the problem with her group saying, "Let me try to get this now."

Another difference that students pointed out was the minimal up-front information that is provided with a PBL problem as opposed to a traditional word problem. With PBL, the students are given a scenario and an initial prompt to start; then, as the group starts to form the lists of things that are known from the problem, and questions that need to be answered, they begin to understand where their investigation needs to be directed. At this point in a PBL problem, critical thinking is needed and, if the student's skills are lacking, it is an opportunity to develop them. Research by Lou, Shih and Tseng (2010) found that PBL was an effective teaching method for building critical thinking skills and problem-solving skills. Traditional lessons use word problems that contain all of the necessary elements needed to solve the problem, and students need only figure out the algorithm to be used in order to successfully solve the problem; however, this is not the case with PBL prompts.

PBL problems require the student to research, investigate and question the facts that are given, whereas with traditional problems usually there is no need to research for information outside of the problem given. A good example of the need for outside information and research was the "Peeps" PBL problem that students worked during the study. This problem required students to know certain facts about Peeps, the popular Easter candy, before they could begin to work toward a solution.

The question asked how many Peeps are sold at Easter in the United States and the facts, such as how many Peeps are produced each year, were given to students in ways that required critical thinking skills. The problem stated that the Peeps Company produced enough Peeps each year to circle the Earth twice at its equator. This required students to research certain facts, such as the physical dimensions of the candy, and the Earth's circumference. Later in the Peeps problem, students needed to research the Earth's population and the population of the United States.

PBL problems require more details in order for students to work the problems, and the students in the study did not seem to mind. I observed that students seemed to be hooked and genuinely curious about problems such as the Peeps scenario. As a mathematics teacher, it was a welcomed change to hear students ask me, with excitement in their voice, what topic would the math question cover that day. Findings from the present study are consistent with other research (Lou et al., 2007) that students benefit from PBL with increased ability for problem-solving skills.

B. Perceived Changes in Motivation, Interest, Confidence, Comfort, Anxiety, and Concentration After PBL

The set of interview questions covered in this section relate to research question two that asks, "In what ways do "at-risk" seventh-grade students who have been involved with PBL math classes perceive changes in their motivational processes (e.g. confidence, interest, and anxiety). How well students can focus in math class is important, as is their perceptions of how well they believe they are able to concentrate. Students who experience math anxiety are at a distinct disadvantage as their working memory is severely hindered (Ashcraft & Ridley, 2005). A student with math anxiety is unable to focus and concentrate solely on the problem at hand

because he or she is also dealing with fear. This makes keeping up with calculations difficult in multi-step problems. This anxiety may lead to a negative attitude toward mathematics.

A negative attitude toward mathematics seems to intensify as students enter the middle grades because this is the point at which the study of math transitions from concrete sequential procedures to abstract algebraic reasoning (McNeil, Grandau, Knuth, Alibali, Stephens, Hattikudur, & Krill, 2006). In turn, this negative attitude may affect the interest level of students as well as their comfort, confidence, and motivation. The responses of students in the present study offer a glimpse into their perspective.

Students were asked how PBL affected their concentration and most of the responses were positive. The student responses centered around the idea that since minimal details were initially given in each problem, students had to figure out what the real issues were and make a plan for a solution. As several of the students stated, this takes a great amount of concentration on the part of the student.

1. Perceived changes in motivation and concentration in male students.

Students with greater intrinsic motivation to learn experience better academic performance, greater conceptual understanding, satisfaction with school, self-esteem, social adjustment, and school completion rates (Center on Education Policy, 2012). Motivation makes a definite difference in how students perform. In some cases, the lack of motivation may be due to a lack of foundational knowledge, which makes learning a particular concept difficult without the prerequisite skills. Students were asked, "How did using PBL affect your concentration and motivation to solve mathematics problems?" The males' thematic response resulted in three of the four male participants stating that both concentration and motivation increased.

Patrick: "It made me stay a lot more focused because it was—there was stuff you

had to find out. Because like, I would want to know if that picture was

actually photo-shopped. It made me curious."

Drake: "PBL made me feel like I could concentrate more on the way to solve the

problem rather the way I am told I have to solve it."

Marcus: "It took more concentration but I did feel motivated. I feel proud of

myself and probably do it better and get better at math."

In analyzing student responses, I noticed several students, both male and female, mentioned that the structure of the PBL problems made them concentrate more than traditional word problems. Another point that emerged during the data analysis phase was the impact the PBL problem had on the motivation of the student. For instance, if the students were really curious about the outcome of the problem, then their motivation to find a solution was much higher; case in point was the Peeps problem and the Starbucks problem. I found a great amount of student effort put forth to solve these problems. I also made contemporaneous notes to this effect in my daily teacher's journal. Increases in interest level are discussed later in this section; however, I see interest in the problem and motivation to solve the problem as related. I also observed that the nature and subject matter of the individual problems had a profound effect on the amount of interest and motivation students displayed during the PBL work sessions.

These findings are similar to research done by Snyder and Shickley (2006) where they found that PBL boosted interest and motivation levels. However, the present study found that interest and motivation levels in mathematics increased, but were also contingent on the nature of the

PBL prompt. The present study found that there was a greater amount of student engagement when the PBL prompt was exceptionally interesting to the students.

2. **Perceived changes in motivation and concentration in female students.**

Similar to male students, female students also acknowledged that the structure of the PBL problems caused them to concentrate harder than did traditional word problems. I observed that students, both male and female, really tried to focus on the initial prompt of the PBL problem, searching for some trace or clue as to what direction they needed to go in order to find the solution.

The female students were asked the same question as the male students, "Compared to other math classes, did PBL increase or decrease your motivation and concentration to solve math problems?" Three out of the four females' thematic response was similar to the males as they also reported an increase in their motivation and concentration.

> Dana: "It increased my motivation. Because I like to do math problems a lot and I wouldn't go on until I finished. I knew that I wanted to get the problem correct and if it wasn't correct, I wanted to like redo my work."

> Monique: "Yes, it helped my concentration because it gave me—like I had to read more. I had to make sure I understood what was actually being asked in the problem. It helped me because it made me concentrate more so I wouldn't miss steps. It made me like kinda go through the whole problem. Like read it once and then read it again for like understanding."

Crista: "My motivation increased because it told me like if you need help, you

have other people that you can talk to and you can work it out as a team

and not be like that one person that doesn't know it."

In analyzing the answers that the female students gave to the question of motivation and

concentration, it appears that the female students placed much more value and emphasis on being

able to work in groups. Several of the students' responses indicated that they were attributing

their increase in motivation and concentration to the ability to collaborate with others in their

group.

The conclusion reached after reviewing my journal and student responses with regard to

motivation and concentration was that the collaboration element of PBL helped these students,

both male and female, to stay on task and kept them focused and motivated to complete the

assignment.

Research by Geist and King (2008) found that traditional teaching methods did not meet the

needs of struggling female students, which, in turn, affected their motivation. Similarly, findings

from Cerezo (2004) found that females fair better with a supportive academic setting. The

findings from the present study supported these findings and the idea that female students were

more motivated in collaborative groups, especially where there were supportive peer

relationships. However, neither of these studies addressed whether grouping should include male

students. The present study found that lower functioning females do better without males in the

group, which is explained later in this chapter.

3. Perceived changes in confidence and comfort in male students.

During the interviews, a few of the male students expressed that being able to get the first PBL solution was key to them feeling more confident going forward. Like any new concept or new venture, PBL was new to all students in the study. The fact that PBL was a new teaching method to them may have also caused a temporary decrease in their confidence.

I found a temporary decrease in confidence based on student interview responses and contemporaneous journal notes during my observations. One of the observations that supported this conclusion happened during the tutorial of PBL prior to the first PBL problem. I observed that many of the students looked nervous, and they also asked a lot of questions that revealed a sense of insecurity regarding this new teaching method. Some of the questions were, "You are going to be here if we need help, right?" and "What if we just can't find a way to solve the problem, I mean, no one in our whole group?" After the study, the students were asked, "How did PBL affect your confidence and comfort to solve math problems?" All four of the male study participants believed that there was an increase in their confidence and comfort. All four males' thematic response was a positive perception of their confidence and comfort pertaining to mathematics after their PBL experience.

> Quantivious: "It boosted my confidence because it made me believe that anything can be done and there is always a solution to every problem, multiple solutions."
>
> Marcus: "I am not as anxious if I kinda know how to start the problem or if I know what the problem is about. I feel very nervous—anxious when I have no idea where to start and I see others working and I am not."

Drake: "It increased my confidence just knowing that when I solve it, other

people know that I am right and they help me figure out why I'm right and

how I'm right."

Patrick: "I am more confident but like it also depends on the problem. Like if I

know how to do it, I am more confident."

After the first couple of days of PBL problems, I saw the confidence levels improve among

both male and female students. The idea that there was no specific way given to solve the

problem no longer bothered the students, and I could see that they were, for the most part,

enjoying the autonomy that the PBL method allowed. The newness of the teaching method was

gone and the ambiguity of how they would work the PBL problems procedurally was also gone.

Similar to research done by Cerezo (2004), the present study also finds that students considered

at risk reported feeling more confident using the PBL method.

4. Perceived changes in confidence and comfort in female students.

Two of the female students expressed some discomfort with PBL largely due to the group

dynamics; one of the females was not a study participant but did participate in the class. From

interview responses, I gleaned that the study participant felt unsupported by the others in her

group. I observed other group members who were participants making comments to this female

student and the other female non-participant such as, "You should be able to figure it out on your

own" and "Why do you not understand?" Clearly, there was a breakdown in the inner workings

of this particular group. Furthermore, this breakdown caused these two students to form a less

than accurate view of how PBL was supposed to work. One possible reason for this breakdown

among group members may stem back to basic social skills. Social skills include being

supportive of one another as well as being able to resolve conflict constructively. To achieve

mutual goals, such as in a collaborative setting, students need effective social skills such as

accurate communication skills and good interpersonal skills (Johnson, 1990).

   In the other groups where the group dynamics were working well, the experience was

completely different. Below are answers from female students who were in two separate groups;

one from the poorly working group and the others from the well working groups. The question

asked, "How did PBL affect your confidence and comfort to solve math problems?" The

females' thematic response resulted in a positive perception and three of the female study

participants believed that there was an increase in their confidence and comfort in mathematics

after their involvement with PBL.

> Dana (member of a poorly-functioning group): "Not that comfortable because
>
> > sometimes I am not sure what I am doing. I get stuck with details like
> >
> > how much something weighs, I get stuck on that."
>
> Allison (member of a well-functioning group): "It increased my confidence
>
> > because like I was not scared to say my answers and like I knew what I
> >
> > was doing. And I am comfortable too. I talk to these people every day and
> >
> > they are my friends. We're close. They would not pick on me for saying
> >
> > my answers out loud."
>
> Crista (member of a well-functioning group): "Well, first it's my favorite subject
>
> > and it brings up my confidence that I know something that maybe some
> >
> > other people don't know and I can help them out."

Monique (member of a well-functioning group): "Yes. Because like when I

solved those math problems I kind of feel like, okay, I know this. And

then I can just keep thinking and like what I was thinking when I did that

problem and then it will also be right and I'll keep knowing what I have to

do so I can stay up with the rest of the class."

There was a significant difference between experiences of females who were working in well-functioning groups and the females who were working in groups where the members did not collaborate with one another. Dana did not have a supportive group, and she felt that she had to find the answers independently.

In one instance, when I asked to see a student's work, which she had just erased, the student told me that she was sure it is wrong, but that the group was still working on the problem. This example showed me that students who struggle in mathematics really benefit from the collaborative process. The fact that she attempted the work tells me that she was trying and when she could not get it correct, she knew she could get assistance from her group members. This is a great example of how the collaborative piece of PBL should work.

The responses above illustrated the point that females benefit when they are in a supportive and collaborative setting surrounded by their peers. These findings are consistent with research by Cerezo (2004), which also found that females thrive in settings where peer relationships were encouraged and supported.

5. **Perceived changes in interest and anxiety in male students.**

The anxiety level in male students did not appear to be an issue based on the responses given during the student interviews and observations made during the study. What's more compelling

was the impact the initial problem has on the student interest and their drive to find a solution.

The question posed, "How did the PBL method affect your interest in problem-solving? Were

the case problems interesting to you?" The males' thematic response, with three of the four

agreeing, was that PBL increased their interest levels.

>Drake: "The case problems were interesting to me. Because the photos really
>
>showed a thought that could be one thing or it could be another thing. And
>
>I had to figure out what it was and how to see it. It [PBL] made me curious
>
>to find other ways to solve a problem other than the one presented."
>
>Patrick: "It made me care more because I really wanted to know. The first one we
>
>did was a box of cereal to see how far back it went and there was a cell
>
>phone beside it and you had to like look up what type of phone it was for
>
>size so you could compare it to the box."
>
>Quantavious: "Uh-huh. I really liked the sports questions. I like sports and so it
>
>was more interesting to me. I really don't like um questions that are about
>
>shopping stuff."

The point that should not be over looked is the important role interest plays in piquing the

curiosity in students. The nature of the PBL prompts played an essential role in engaging the

students. If the PBL prompt was interesting, then the study participants were more inclined to

stay engaged and find a solution. Based on student answers and observations during the study, if

there was a great deal of enthusiasm regarding the solution to a particular PBL problem, you

could feel the excitement in the classroom. If, however, the element of enthusiasm was lacking,

based on my observations, the learning environment was completely different, stagnant.

6. Perceived changes in interest and anxiety in female students.

Regarding interest, the same findings applied to female students as to the male students. As long as the initial PBL prompt contained subject matter that the students were passionate about, there was a very enthusiastic atmosphere in the classroom, but the opposite was true if the initial prompt was considered boring to the students. The female students also liked problems that seemed to be personal for them or someone close to them. The females' thematic response in regards to whether PBL increased their interest level was positive because all four female study participants affirmed that their interest levels did increase contingent on the nature of the PBL prompt.

> Monique: "It depends on like the actual problem of how much interest I have in it. Like if it's something that's like it affects someone near me or someone that's close to me or if it affects me, then I'm kind of more interest in what that problem is. Like I have more interest to find the solution."
>
> Dana: "You have to figure out how much snow weighs on the roof of the car and how—you have to solve to find out how much it weights and things like that—that's interesting."
>
> Crista: "It [PBL] brought it [interest] up because it helped me out. I feel like I can keep trying until I get it."
>
> Allison: "I think I started to like it [problem solving] more because like I wasn't scared to say my answers and my friends would like help me and I could work better."

The subject matter that piqued the interest in females differed greatly from what interested male students. However, being able to hook the students and have them vested in the problem is a key element to motivating them to complete problems. I observed a dramatic drop in the interest level of female students with certain subject matter such as sports. Those problems that pertained to sports did not hold the attention of female students.

Research by Snyder and Shickley (2006) found that struggling students benefit from collaborative groups because their interest as well as confidence levels were boosted by collaborative work.

Summary

The students in this study reported being very positive about working in groups; which is a key element in PBL. This allowed students to share their thoughts with other group members in order to gain confirmation of their answers or clarification of why their answers may have been incorrect. In either case, it allowed students to feel successful by completing the problem with some measure of certainty of the correctness of their answer.

Interest levels among study participants were largely contingent on the nature of the PBL prompt. If students, both male and female, were curious about the type and outcome of a PBL problem, then they were more inclined to remain diligent in searching for a possible solution. If, however, the students could not relate to the PBL prompt, then attentiveness, interest and diligence sharply declined. Case in point was the sports question regarding statistics. Female students, for the most part, had no interest in finding a solution for this particular problem.

Not surprisingly, the majority of students reported discontent with previous math class experiences leading up to the PBL unit, and the majority of these students expressed positive

opinions regarding their PBL experience. Multiple students cited that the latitude offered with PBL was a welcomed change. Specifically, they liked to be able to approach the problem without preconceived notions of what was expected. Several students mentioned that the open-ended nature of the PBL problems caused them to concentrate more in order to understand how the problem could be solved. Students reported an overall moderately high comfortable level with PBL due to the fact that they could collaborate with group members and could determine their own way to solve each problem.

II. Gender Differences and Influences on Perceptions of Learning and Motivation

In this section, students shared their thoughts on the role gender played in the learning of and motivation to do mathematics. This section relates to research question number three, "In what ways do gender differences influence the perceptions of learning and motivational processes by "at-risk" seventh-grade students who have been involved with PBL math classes?" I have compared my observations with the student responses to see what connections can be made. It has been well documented that STEM related subjects such as mathematics are not as heavily pursued or pursued with the same zeal by females as males (Sydell, 2013). However, it may possible that some alternative teaching methods used to teach mathematics are more likely than traditional teaching methods to encourage greater participation by females (Geist & King, 2008).

A. Student Perceptions and Observations of Gender Differences

Based on student interview responses, male students generally focused more on their ability to explain a concept or their ability to logically debate a topic or defend a position. Female responses generally focused on how the dynamics of the group affected their willingness to share

what they knew regarding a particular topic or in the alternative, what they did not know. My observations showed that females were much more reserved than males when discussing or debating topics or defending positions.

   1. **Male perceptions of gender differences.**

Male students, for the most part, agreed that gender was not the main factor in considering how to group students. Instead, they thought the functioning of a group was predominately determined by students' willingness to articulate their point of view on a topic and ability to contribute to the solution. Male students appeared to be concerned with the notion that if the student is going to offer a solution, can they fully explain their reasoning. The question posed, "Do you think the boys would have learned math better with PBL if our group were all boys or learned math better with boys and girls together, why?" The males' thematic response was that gender is not as much of a factor as being able to contribute to the group. Three of the four male study participants agreed with this position.

> Drake: "There's not really any conflict between males and female. Just more of
>
> thought about what we are learning and how they are going to learn it."
>
> Patrick: "I don't think it really affected anything [mixed groups] because like
>
> when I looked around, everyone was still doing their part, so…"
>
> Marcus: "Usually we have like all boys, and you can just like not pay attention,
>
> play around. But if you have a mixture, like everyone has like a different
>
> thought and you just like can get more out of it and pay attention more."

Male students liked working with females as long as they contributed to the solution and as long as they could explain how they arrived at a particular solution.

2. Female perceptions of gender differences.

Some of the female students expressed similar feelings regarding students' ability to articulate the reasoning behind a solution. Several of the female students said that they liked for their group members to be able to explain how they arrived at their solutions. My observations were consistent with this because I noticed that both males and females wanted to be confident of a group member's work and frequently asked members to prove that their answers were correct. One point made by two females was on how students were grouped. They would have liked to be grouped with others, irrespective of gender, at the same level of ability.

Another point made by the one of the females was that "learning styles" should also be factored into how the students were grouped. The question posed, "Do you think the girls would have learned math better with PBL if our group were all girls or learned math better with girls and boys together, why?" The common thematic response by female students was that grouping should be same gender. Three of the four female study participants expressed this as their idea of effective grouping.

>Allison: "All girls because guys are a little bit more competitive and like to yell out, and girls are like they don't have nothing to like keep them off track or he's cute or something like that."

>Crista: "All girls. So they could just talk it out with them and like not—like some people can't talk to like guys."

>Dana: "All girls because when it's boys all they do is chat and play. And girls do not want to embarrass themselves, especially if like they have feelings toward that person, so it kind of would affect their learning."

Three of the four female study participants believed that same-gender grouping was more beneficial than mixed-gender grouping. Allison cited competitiveness as being what she sees as a gender difference in learning. Monique was the only female study participant who believed that ability and skill level should be considered rather than gender in regard to grouping students for PBL.

> Monique: "I don't really think their gender role is more important than what they're learning because it's more like who has—like the same knowledge that they do. Because if you're in a group with people who have the same methods as you it's kind of easier because if someone has a different method than you, you're going to be confused on how they got their answer. So, I think they're like—if it was just a girl's class, it wouldn't have much of an effect on what they were actually learning but it would if all of them were at different levels."

Several of the females mentioned that it was difficult to concentrate on learning when group members are males because they feel inhibited or distracted by the males. The females expressed concerns ranging from being embarrassed to contribute for fear that they would be proven wrong by the male group members to not wanting to debate with males that want to dominate the discussion. Only one of the female study participants thought it would be all right to have mixed-gender groups as long as the students were of same ability level.

3. Researcher observations.

The observations I made revealed that there is a difference in how females and males learn concepts and discuss issues. I observed the domineering ways that males try to win a debate,

regardless of whether they are debating another male or a female. I also took note that females, for the most part, but with a few exceptions, are willing to back down when defending their position if they are debating someone who has a stronger personality. There also seems to be this belief that if a student has a history or reputation of being smart, as viewed by other students, they automatically are assumed correct every time, and thus, this student's answer is the one that everyone else in the group adopts.

> Patrick: "Because like whenever someone would say—like we'd each have a different idea, whoever was usually got more stuff right or was smarter, we'd go with them. We wouldn't like decide, we'd just say, okay you are right."

Regarding the points made on grouping by students like Monique during the interviews, it seems logical beyond her years that she would consider grouping based on learning styles or ability level. However, it is a point well taken and one that is discussed at length in most meetings among teachers and administrators. Even researchers still debate the merits of same-sex verses mixed-sex groupings on student performance (Cairns & Fraser, 2015). I believe, based on my observations, students are individuals and strategies that work for one group may not work for another. Males and females in one group may work well, and then in another, it may be disastrous in terms of productivity and effectiveness.

In the lower performing groups, mixing males and females together appears to have a negative impact as it appears to hinder students considered at risk, especially female students. However, in higher performing clusters of students, it has been my experience, that this issue of grouping males with females was minimized. In the lower-performing groups, there are students

who are insecure about their abilities in mathematics, and they are much less likely to voice their opinion for fear of being wrong. For females this is much more pronounced because they would feel inadequate if they were proven wrong in the presence of male students or perhaps dominated by a stronger personality.

Summary

The male students paid very little attention to gender. Several male students said that they had to work in groups with females in other classes and because of that, they were used to it. In my observations, I noticed that most of the female students had a difficult time defending their position if a disagreement arose between group members. In mixed groups, rather than defend their positions, these female students considered at risk, would shrink and concede to other group members. I think the reason they did not debate their positions was because they did not want to risk failure and be humiliated in front of male students if proven wrong. Based on my observations, I believe that female students have more of an issue with looking "less smart" in front of males but not as much of an issue with this in front of other females. When viewed in this light, it makes sense to group these students with others who can allow them to debate without risking their personal criticism. These students seem to have more confidence in their work when placed in female groups.

Several of the students mentioned the importance of group members being able to explain why their solution was accurate. Male students placed a lot of emphasis on group members being confident in their answers, regardless of gender.

Research by Samsonov, Pedersen and Hill (2006) found that PBL should be reserved for students who are capable of functioning at higher levels. Their recommendation did not address

gender as much as skill level. They found that if teaching methods such as PBL were going to be used with lower-functioning students, then grouping should be done by pairing low achievers with high achievers.

The present study differs from these findings. The present study finds that the use of teaching methods such as PBL can benefit students who struggle. However, low functioning female students may benefit more if grouped with other females. Additionally, placing advanced or high achieving students in the same group with students who struggle may prove to be a mistake because it could frustrate the more advanced students (Cleaver, n.d.). A consistent theme among both male and female students in the present study was a desire to be grouped based on similar ability and skill level.

III. Perceptions on Grouping and Gender Differences

The group aspect of PBL was very well liked by all of the students in the study. There were only a couple of students, both in the same group, who felt that their group was not on task. Here again, the reasons students offered varied as to why they thought working in a group was such a good practice.

Many of the students expressed satisfaction with the notion that they did not have to work independently. For these students, group work was a welcomed change because they do not believe that they could achieve the answers without help. This idea is linked to Vygotsky's zone of proximal development (ZPD). Vygotsky stated that a child follows an adult or a more knowledgeable other as an example and gradually develops the ability to do certain tasks without help (Vygotsky, 1978). Although Vygotsky's focus was on the developmental stages for children and not classroom application, Vygotsky made the point that we cannot just look at what

children are capable of doing on their own; we have to look at what they are capable of doing in a social setting (Wood, 1975). In many cases students are able to complete a task within a group before they are able to complete it on their own (Crain, 2010).

A. Students' Preferences on Grouping

In coding the data, I created a frequency chart in order to detect trends (see Appendix D). One of the codes was SGEN, for same-gender grouping, and the other was MGEN for mixed-gender grouping. Any responses that pointed toward either of these codes were tallied. I categorized the data based on gender and grouping preferences. Based on the frequency chart, the responses from females revealed that females prefer same-gender grouping as opposed to mixed-gender. In the case of the male responses, it was clear that males preferred mixed-gender grouping.

1. Mixed gender verses same gender grouping.

While all of the students in the study agreed that working in a group was worthwhile, there were differing views as to how the grouping should be determined. Several of the students believed that grouping should be determined by ability and not gender. Most of the students, on the surface, mentioned that gender is irrelevant but then contradicted themselves by offering reasons why the grouping should be mixed-gender or same-gender. On questions concerning mixed-gender or same-gender groupings, the thematic response from male students was that it really did not make a difference. It only mattered that the group functioned well to achieve a solution. The males' thematic response was that grouping according to gender was not important. Two of the four male study participants expressed this opinion and the other two believed that same-gender grouping would be best.

Patrick: "It doesn't really affect me. Like I—whatever works best for the teacher.

Like if there's ten girls and four boys, there will probably be more girls

than boys so, like, you're going to have to deal with it. It's not that big of a

deal to me."

Drake: "They [boys] would probably feel more comfortable if it was all boys

because they could talk to the guys and then there would be no

interference from the girls but they would be better off with girls and

boys."

At the middle-school level, insecurities are commonplace and students, both male and female, have a hard time dealing with being told they are wrong. Apparently, girls are not the only ones who may be insecure when offering a solution to the group.

Marcus: "They [boys] feel like if they answer and they're wrong, they feel like a

girl makes them feel like they're always wrong."

When asked if males and females should be grouped together or separate, female participants believed that same-gender grouping would work best. The female study participants' thematic response was that grouping should be same-gender. Three out of the four female study participants expressed this opinion.

Allison: "All girls because the guys are more rough and louder or they can like

yell out answers and get the girls all mad or flirt with them and keep them

off task."

Crista: "Girls because some people can't really talk to like guys and other people

that they don't really know. And like they click with other people and not

just be like nervous around that person and won't talk because it's not like

in their comfort zone."

Monique: "A lot of girls, they are kind of shy around like other boys. So when

there's other boys they don't really want to embarrass themselves so they

won't ask as many questions because they think, oh, that person already

knows the answer to what I'm about to ask. So, I think they would

probably prefer to be grouped with girls because they know, ok, if I don't

know then I'm not really that shy around other girls who probably don't

know the answer either."

2. Why grouping preferences matter.

A few students who felt that their group was not as successful cited several reasons for the issues within the group. The biggest reason these students believed that their group performed poorly was due to other group members not wanting to work and wanting others to provide the answers for them. Essentially, these students did not feel as though they had a group with willing participants and there was a struggle to keep the group focused. The question students were asked was if working in a group affected their ability to solve math problems.

Drake: "It helped because I had a group of people to help me with stuff I didn't

know and I could help them if they didn't know."

Crista: "Yes, but people in our group were like trying to get off task and we kept

trying to pull them back and they just kept on going on to stray by

themselves."

> Dana: "It was good but you can put me with good group members or like people who stay focused and help the people who don't get it."
>
> Monique: "Most of the time it was good, but you had to rely on your group and if your group members didn't know what was happening then most of the group wouldn't know either."

It became apparent to me with these responses that students have definite opinions on grouping. Both male and female students said they would feel slighted if they were placed in a group that was uncooperative or a group where they did not feel accepted. Another issue raised by students in the interview was group members who simply did not stay on task. This was a source of irritation for some of the female students.

These students were discovering how important it is for a group to be able to work synergistically. For effective functioning, each group member contributes and the result is a product greater than individuals working alone. To work synergistically, is to create a whole that is greater than the sum of its parts. Mastery of this skill is coveted in the work place and can be taught in school by means of teaching methods such as PBL.

Research by Frost and Wiest (2007) found that collaborative learning situations were a key component to skill development. Their research found that collaborative learning environments helped students understand the relevancy of concepts taught and also boosted self-efficacy. Similarly, the present study also finds this to be true. Students benefit when they can collaborate with others in finding a solution to the problem. This collaborative element allows students to gain knowledge in an informal way from others who may better understand a particular concept.

3. How gender affects the group dynamics.

The key to group work appears to be making the group dynamics effective by teaching social skills and placing compatible members together (Johnson & Johnson, 1989/1990). As previously stated, it is important that group members feel accepted and valued within their group. Students also need to feel as though they can ask other group members for help and not be chastised for it. Groups that worked well together had positive comments to make regarding the group aspect of PBL. Comments made by group members from well-formed groups provided the proof that group dynamics matter; that students need to feel comfortable working within these groups in order for them to be productive. In general, male participants tended to focus on ability rather than differences in gender. Three of the four males believed that gender did not play as big of a role in grouping as did the ability to work well together.

> Patrick: "There were more people you could talk to so if you got lost you didn't have to ask the teacher; you could ask someone beside you."
>
> Drake: "In the group there are multiple ideas thrown around and that helps with you trying to add on to your idea and then you can put that idea out there and then they add on to your idea."
>
> Quantavious: "I like that it's a group effort—so it works and helps you learn because sometimes in jobs you have to do things to help other people. And this makes you a leader because if you solve it and then you explain it to other people, it helps you."

Females expressed the possibility of feeling inadequate in front of male students and how this might affect them and their learning. Females also mentioned that males can be dominant and competitive.

> Crista: "Some of them [girls] would think that all guys are like rude and all that and would be mean to them, like, oh, you don't get this, well you need to work it out yourself."
>
> Alison: "The guys would be saying I got the answers first or whatever. And girls will not answer if boys are there for fear of like the guys won't like them and call them names or like flirt. Their way of flirting is being rude and disrespectful."
>
> Monique: "Like some guys, they will get too close to you or you just naturally don't want them there. So it kind of makes it harder to like talk to them and try to figure out what you're solving."

Female student responses revealed that females' perceptions of mixed-gender groups complicated the collaborative process. Their responses showed that they felt inhibited at times when grouped with males.

Research by Werner and Denner (2006) addressed the dominant and competitive dispositions many males exuded and found that females did not perform as well when in the presence of males who displayed these types of attitudes in the learning environment. The present study concurred with these findings and also agreed that females reacted positively in collaborative settings because they were aligned with their social interests and needs for peer acceptance.

Summary of Student Perceptions

The goal of this research was to find out if, after involvement with PBL, students perceived changes to their motivational and learning processes. Students' perceptions of motivation, confidence, anxiety, comfort, concentration and interest after their involvement with PBL were explored. This study also explored how working in a group affected students' ability to solve problems and what role gender may play, if any.

Student responses revealed that the latitude of learning choices in an experiential teaching method, such as PBL, was motivating and enticing to students. This idea of having the freedom to choose how to solve a problem really resonated with student participants of this study. Students expressed satisfaction with being able to determine for themselves the best methods to solve a problem rather than being told which method to choose. According to student participants, the open-endedness and minimal details of the initial PBL question prompt resulted in greater concentration and effort put forth to solve the problem.

Student responses also revealed that the subject matter of the PBL prompt was very important for motivation to learn. If the initial PBL scenario piqued student interest, then they were motivated to continue. This motivation provided the students with the determination to persist even when their answer was incorrect, causing them to go back and reconsider their solution. Sheer curiosity as to possible solutions kept most of the students pressing forward, even after initial setbacks.

In discussing grouping, students were more concerned with being comfortable working with an individual student in their group based on their cooperativeness rather than the gender of that student. Acceptance, staying on task and nurturing of ideas were qualities and skills expressed by

students as being important to group members, more so than gender. Additionally, student interview responses revealed that students appreciate being grouped with individuals of the same ability and skill level. Female students made the point that competitive individuals hindered their learning. These students expressed that their preference was to work in groups with students who supported them rather than competed with them.

The present study found that PBL worked well for students considered at risk. The collaborative nature of PBL was aligned with meeting the social needs of females and also increased the interest levels of males. This finding differed from research findings by Samsonov, Pedersen, and Hill (2006) that indicated PBL should be used with students who are high functioning. Samsonov et al. (2006) recommended that if PBL were to be used for low achievers, it should be done so by pairing low achievers and a high achievers and forming groups this way. The present study found that the perceptions of students were that groups should contain similar ability levels. By grouping students with similar ability levels, it increased students' comfort levels as well as confidence levels.

Regardless of gender, skill, or ability level, if the dynamics of the group were not good, then the group did not function well. This point was made during the study with a group that did not have willing participants. The reasons for the unwillingness of these group members to work well may be attributed to a lack of social skills for working with others, gaps in their learning, and a lack of desire to stay on task. Whatever the reason for the breakdown in the group dynamics, the end result was a lack of productivity and learning.

CHAPTER 5

SUMMARY AND CONCLUSIONS

This case study explored the perceptions of seventh-grade mathematics students who were considered at risk to determine if an experiential learning method, problem-based learning (PBL), could motivate and empower these students. In attempting to improve mathematics education for middle-school students considered at risk, the study sought to determine if students perceived PBL to be an effective teaching method and how those perceptions were influenced by gender. One of the goals of this study was to investigate how the perceived learning and motivation needs of "at-risk" female and male students were met by PBL but possibly in different ways. This research was designed to explore the students' perceptions of PBL to understand more deeply the different needs of these students and how to best meet those needs.

The study was relevant to middle-school mathematics teachers because it sought to find out, from the student's perspective, if PBL was effective. It is a known fact that enrollment numbers for female students are substantially lower than their counterparts in higher-level mathematics classes (Faller & Holden, 2015). This downward spiral begins in middle grades and continues throughout their high school and college years (Cerezo, 2004). The lack of interest in mathematics by female students has far reaching effects as lower numbers of females earn degrees in STEM-related subjects such as mathematics and science. Essentially, these female students are allowing themselves to be deemed ineligible for a vast array of jobs housed under the STEM umbrella. This is particularly troubling as jobs in STEM related fields are some of the most rewarding in terms of compensation. STEM related jobs will account for a large portion of available employment by the year 2020 and ensures one of the smallest wage gaps among

employment opportunities between males and females (American Association of University Women, 2008).

There is a very real need to understand why females, for the most part, avoid higher-level mathematics as well as STEM-related careers after graduation. The ramifications are too great not to investigate this issue. Some of the ramifications are issues that affect the student on a personal level, including quality of life and earning potential. Other issues affect our society in general, such as having enough credentialed individuals qualified to fill STEM jobs that will be available in the near future. Struggling male students will also be needed to fill STEM-related jobs; therefore, finding teaching methods that work for them is also critical.

Educators need to understand which teaching methods are effective for motivating "at-risk" students. By investigating the perceptions of these students, we can find out how best to motivate and teach these individuals.

Summary of Study

This case study consisted of eight students from the seventh-grade who are considered at risk for failure in mathematics. The goal was to have a balance of males to females and a range of races, which was achieved. The racial make-up of the participants mirrored the racial makeup of Tatum Middle School. The specific criteria used for inclusion in the study consisted of (A) seventh-grade student, (B) at risk of failing mathematics for the school year, (C) previous record of failure in mathematics in terms of grade averages, and (D) failure on previous mathematics standardized tests.

The setting for the study was a small, rural middle school on the outskirts of Augusta, Georgia. The area within which Tatum Middle School is located is a high-poverty area. Tatum Middle School has greater than 51% of its students receiving free or reduced lunch; which qualifies it as a Title I School. Tatum Middle School serves less than 550 students across grades sixth through eighth, and as such, within Columbia County, Tatum Middle School is considered small relative to other middle schools.

Students who participated in the present study were asked if they recalled using experiential teaching methods such as PBL. None of the participants recalled using an experiential learning method; thus a tutorial was held to familiarize study participants with the procedures and intricacies of PBL. Students were able to practice with a PBL problem that contained limited mathematics during the tutorial phase to prepare them to concentrate on the process rather than the product. The practice problem was particularly important as it emphasized the importance of asking questions in order to make informed decisions regarding possible solutions to the problem.

After ensuring that the procedures of PBL were understood, students began a PBL unit in their mathematics class. The PBL unit used for the study aligned with the current Columbia County pacing guide and covered standards that were mandated by the state for all seventh-grade mathematics students. The mathematical concepts covered in the PBL unit consisted of topics in geometry, including surface area, and volume, followed by, topics from the statistics and probability unit including mean, median, mode and range, as well as mean absolute deviation.

Each day the students were grouped and then given a PBL prompt. Some PBL problems could be finished the same day as started; however, other PBL problems were more complicated

and, therefore, could not be completed as quickly. Students stayed in the same group until the completion of the PBL problem.

Observations were made during the PBL work sessions to determine if there were any detectible differences in how the males and females learned and interacted within a group and with PBL. A daily journal was kept to record day-to-day observations and additionally a formal observation was scheduled each week (see appendix A). A reflective journal was kept and student interviews were conducted two days after the PBL unit was completed. A semi-structured list of interview questions was used with each study participant (see appendix B).

Discussion of Findings

Findings from the present study suggested that there were common themes among the "at-risk" students pertaining to whether PBL was perceived as effective for learning mathematics. This research was viewed through the theoretical lens of Vygotsky's sociocultural perspective to account for the collaborative element present in the study whereby students were expected to learn in a social context with one another. The data were gathered and organized and then analyzed using three research questions that guided the study regarding the perceptions of seventh-grade mathematics students considered at risk. The research questions centered on students' perceptions of changes to their learning and motivational processes after involvement with PBL as well as how gender influenced these perceptions.

The next section will address each of the three research questions, which guided this study. The discussion will center on what the common thematic responses were in regard to the research questions. Additionally, these common thematic responses from the present study will be juxtaposed with other research to see how the findings compared.

In What Ways Do "At-Risk" Seventh-Grade Female Students Who Have Been Involved In PBL Math Classes Perceive Changes In Their Learning Processes?

The female students in this study expressed a common theme of satisfaction with being able to work in collaborative groups where they shared information they knew and gained information from others in instances when they did not know or understand. This give and take of information gave these students the motivation to keep trying even when the work was difficult. These students expressed that there was a great amount of comfort in knowing that they could talk to their peers if they could not do the work on their own. This response fits perfectly with Vygotsky's ZPD as these female students are able to work with others who were more knowledgeable about a particular concept and then gradually they were able to complete the task independently. This thematic response was also consistent with the research of Cerezo (2004) who found that females in middle school benefited from collaborative PBL environments where there were nurturing peer relationships.

Similar to the present study, the middle-school female students thrived when they were given the opportunity to learn in an academic setting free from competitiveness. It appears that they had emerging emotional needs during this time in their life, which included a strong need for acceptance by their peers. This social interaction, within a collaborative setting, among female students, played a fundamental role in their ability to develop and master mathematical concepts.

Equally as important to them was the thematic response that, when they knew how to find a solution, they could share it with the group and show that they could contribute to the group in a meaningful way, thus building confidence and self-efficacy. This was a strongly emphasized response among most of the female students and one that was shared with the male students; the

reported perception that they knew enough about a concept to help another group member. It takes a really good understanding of a concept for students to be able to impart that knowledge to another student. The fact that they explained it to another student, in turn, reinforced their own understanding of the concept, thereby yielding an additional benefit to the student.

Female students also reported the thematic response of liking the open-endedness of the PBL problems. Related to this thematic response and expressed by both female and male students was the opportunity to discuss the problem with their peers and then chose the best approach to the problem. This was a perception expressed time and time again by student participants. Some female students said they felt comfortable with PBL citing the fact that they had the freedom of choice and the time to investigate and think about the problem and then determine the best way to solve it. This approach was a departure for these students who are used to being given a problem and then told which algorithm must be used to solve for the answer.

All of the female participants reported that they liked knowing that there were many ways to solve the problems and that there were many different solutions for each of the problems. In this light, students mentioned that their experience with PBL showed them that their answer was not wrong just because their answer was different from another group's conclusion. This was another commonly expressed perception that resonated with female students. As one student mentioned during an observation, "We all think about things in different ways and it makes sense that we would have different ideas about how to solve the same problem."

In What Ways Do "At-Risk" Seventh-Grade Male Students Who Have Been Involved In PBL Math Classes Perceive Changes In Their Learning Processes?

For this research question, male study participants were asked interview questions that included their previous math experiences. Study participants were asked questions such as how well they had done in previous math classes and then they were asked to compare their previous experiences with their recent involvement with PBL.

Almost all of the study participants, both male and female, reported feeling some degree of math anxiety in previous math classes. Their reported perceptions of changes in their learning processes revealed changes in their motivational processes of anxiety. Math anxiety disrupts a student's ability to concentrate on the task at hand as it blocks working memory (Ashcroft & Ridley, 2005). Anxiety causes the student to focus on whether or not they possess the ability to solve the problem rather than putting that same effort into finding a solution. The males were more reluctant than females to admit to feeling anxiety over math, but interview responses revealed that it did exist.

It was expected for students at risk of failure in mathematics to have some initial level of math anxiety with a new math learning method. Previous years of struggle and failure in mathematics likely have taken a toll on their self-efficacy. Devine, Faucette, Szucs and Dowker (2012) found that higher levels of math anxiety adversely affected future math endeavors due to reduced student self-efficacy. However, after their PBL experience, male students reported feeling a sense of calmness and quiet confidence in their ability to do mathematics with PBL.

Working in isolation can be difficult for many students who struggle with mathematics. Male students in the present study cited the ability to work in collaborative groups as a positive component of PBL. They liked to be able to build on to the ideas of each other. Snyder and Shickley (2006) found that working collaboratively increased interest levels among students.

In What Ways Do "At-Risk" Seventh-Grade Female Students Who Have Been Involved In PBL Math Classes Perceive Changes In Their Motivational Processes (e.g., Confidence, Interest, Anxiety)?

Interest and confidence were severely lacking prior to and at the beginning of the PBL experience for female study participants. Prior math classes left most of the female study participants feeling inadequate as it related to their mathematic ability. From my formal observations, I saw that the females were extremely reluctant to participate in PBL initially.

It was almost as if some of my students exchanged roles. One of the female study participants, Monique, who I observed being on task each day since the beginning of the school year, had a difficult time with PBL in the beginning. She expressed some discomfort with this method of teaching. Her real issue, from my observation, was that she had not fully developed confidence in her critical thinking and problem-solving skills.

To be given a PBL prompt and then asked to start mapping a strategy was overwhelming for Monique. Her preference would have been a work sheet with a familiar algorithm situated within her comfort zone. Monique was not the only female who felt this way regarding PBL.

On the other hand, I had a male study participant who was just the opposite of Monique. Drake was very complacent for most of the year, completely unmotivated to do his math work and most often did not turn in assignments during the time prior to PBL. When we started the PBL unit, Drake suddenly and noticeably became one of the top problem solvers in the class. In fact, he was the student I wrote about in my teacher's journal. Each day during the PBL unit, usually during homeroom, Drake, very excitedly, would ask me what the PBL question was that day. I found the reversal of roles between these two students during PBL quite interesting.

However, I observed that, as time passed, and the female study participants had time to adjust, their attitude toward PBL slowly began to change. The conversations that I was now overhearing were productive and not pessimistic, and the female students were beginning to explore ideas. Their conversations with me also changed, giving me details of ideas they were exploring as possible solutions for the PBL problems. I could see changes in the female students because they were becoming more confident in their ideas and strategies.

The collaborative experience of PBL was also positive for the female study participants; however, the dynamics of a group played a significant role determining whether a group would function well.   In contrast to this, the male study participants were not as focused on the group dynamics as the females. Group dynamics and grouping are discussed later in this chapter.

Interest level in the PBL problems was contingent on the kind of problem. Females were particular about which PBL problems piqued their interest. For a problem to interest them, it needed to be something personally relevant to them such as the Peeps problem or the Starbucks problem. If it was a sports-related problem, the female study participants immediately lost interest. Male study participants were not as affected by the content of the PBL problem. If the male students could "win" by getting the best answer, or the first to get a good answer, then they were happy.

The competitive aspect was something that the female students disliked about traditional teaching methods. However with PBL, the males could be competitive as long as they were in separate groups from the females. This is another reason I suggest grouping females in same-gender groups, which is a discussion I will have later in this chapter.

In What Ways Do "At-Risk" Seventh-Grade Male Students Who Have Been Involved In PBL Math Classes Perceive Changes In Their Motivational Processes (e.g., Confidence, Interest, Anxiety)?

The confidence levels of male study participants were enhanced by their PBL involvement. Based on my observations and interviews, it appears that male study participants did not suffer from low confidence after their PBL experience. Male study participants only suffered from a brief feeling of insecurity during the initial phase of the PBL experience. This was expected since they were placed in a new learning situation. After they became acclimated to the collaborative PBL setting, they did very well.

However, confidence can be fleeting from one mathematical concept to the next. A student may do very well with one concept and struggle terribly with the next one. With this understanding, it was revealing to me when Drake answered the question regarding confidence solving math problems after involvement with PBL. He said he was, for the most part, confident about his mathematical abilities, but when he was correct, he wanted affirmation from his peers, and also he wanted to understand why he was correct. When these male students considered at risk received commendation for their work, it appeared to boost their confidence.

The male study participants were asked if the PBL prompts increased their interest in problem solving, and most said that relevant prompts piqued their interest and made them curious. This makes sense to me when I think about students that I have taught with traditional methods. Anytime the question used material that was part of their daily life, such as music or certain foods, it stirred something inside of them, which caused them to be intrinsically motivated to find a solution to the problem. And with the PBL unit, I observed students who wanted to do

further research on some of the problems, even after our discussion was finished. Case in point was the statistics problem where some of my male students wanted to go home and analyze the statistics of some of their favorite players.

Male study participants expressed great satisfaction with the freedom that PBL offered them of being able to choose how to best solve each problem. This was a recurring theme among male and female study participants. The idea that they could strategize and chose how to solve the problem in different ways probably reduced the stress and anxiety of finding a solution.

In What Ways Do Gender Differences Influence The Perceptions Of Learning And Motivational Processes By "At-Risk" Seventh-Grade Students Who Have Been Involved In PBL Math Classes?

Most study participants in the present study indicated through some of their answers during the interviews that gender does not matter when asked if males and females should be grouped together. The most consistent response was that gender is not as important as ability level. However, based on my observations and experience in this study, I take exception to their response.

My observations revealed that females who felt inferior with regard to their mathematical ability needed to be grouped with students who would work with them in ways that did not squelch the limited amount of confidence they possessed. These students needed to be grouped with others that allowed them to express their ideas without fear of being judged. It also appeared to me that the female students were much more inhibited when grouped with males.

Every student is an individual and each grouping situation is different. During the present study, I witnessed that each time the group members changed, the dynamics of the group also

changed; sometimes, the change improved the dynamics of the group and, sometimes, it damaged the inner-workings of the group. However, the effects of changing group members on the group dynamics were not always centered on gender. Sometimes students of the same gender, with equally strong personalities, who were grouped together, caused the group to function poorly and gender was not an issue.

In terms of consistent gender differences, I observed that females and males had different attitudes toward learning. Males tended to want to make everything a competition. They wanted to get the answer first, and then they wanted to be recognized for having the best answer. Being recognized for excelling academically was a common theme for males because they wanted to compete and dominate. I saw this firsthand while they were working in groups. Their tendency was to over talk or out talk anyone that contradicted them. Keep in mind, this was a general observation, and there were exceptions, but by in large, the males wanted to win and they viewed most tasks as opportunities to prove their intellect and dominance.

Typical classroom dialogue included male-dominated conversations, such as, a male student from one table yelling out, "We're done!" And a male from another table of students, over hearing this yelled out, "Well we've been finished," and the male response was, "Yeah, because you saw what we were doing and copied us." This was typical male behavior from what I observed not only during this study, but also from years of experience in teaching. The point that the male students missed was that the goal was to get everyone to be successful, and success was not determined by who finished first. This was a point that I believe most of the female students understood.

The females, however, were much more reserved. They were not as individualistic as the male students; they had a genuine interest in helping one another. The male students wanted to help one another too, but the drive to be first and to be applauded, as the one who got the correct answer, was very strong, and they wanted the recognition. When the male students struggled in the groups, they were appreciative of having a group with which to work and then, when the group collectively discovered a plausible solution, the male students were pleased with the fact that their group was the first. In other words, if the males could not score an individual win, then at least their group could win.

My observations showed that female students had a better understanding of the fact that sometimes you might do well with a particular concept and the next concept, you might struggle. I do not think the females viewed learning as a competition; they saw it more as something that they had to do, and they wanted to be able to correctly do it when it counted as an independent grade. The female students that I observed showed compassion for others in their group that struggled. Males, however, made comments such as, "How can you not get this?"

Based on this study, it is my belief that females who struggle in mathematics might benefit more from a grouping situation that is same-gender. There are exceptions to every rule, but I believe that females are much more understanding of those who struggle, and this type of collaborative environment offers needed support for these students.

Limitations

Several limitations existed with the present study. The findings for the present study were limited to participants from a small, rural Title I middle school, where over 51% of the students were on free or reduced lunch. Findings may have been different if it had been conducted in a

larger middle school where the average family household income was greater. The present study was limited to eight student participants. Because the group of study participants was small, the findings from the present study cannot be generalized to the vast majority of students. Also, related generalizations about gender differences cannot be made because of the small sample of male and female students. Additionally, findings were limited to a middle school and may have been different if the study had been conducted in an elementary or high school. Finally, observations were limited to only one per week for a total of three. And the researcher had to do multiple jobs during the course of the observations including: guide the PBL session, answer student questions, and make sure students stayed on task. Observations may have yielded more data had the observations been conducted by someone whose only job was to observe. Another limitation of the present study included the fact that the researcher was also the teacher for this group of students, and because of that, students may have been inclined to give answers that they believed would be pleasing to the teacher.

Educational Implications

The implications of the present study, which will be discussed in the next section, will center on students' perceptions of the formation of collaborative groups and whether groups should be formed based on gender or ability. Also, students' perceptions of PBL will be examined to see if this alternative teaching method met the needs of these "at-risk" students. Finally, students' perceptions of working collaboratively and possible gender differences will be discussed.

Collaborative Academic Settings

The present study's findings were consistent with Vygotsky's (1978) theory of the zone of proximal development (ZPD). ZPD describes the difference in what a student can accomplish independently compared to what a student can accomplish with the aid of another who has a better grasp of the concept. What a student can accomplish on their own is not a complete picture of the capabilities of that student; therefore, we should also consider what the student can accomplish within a collaborative setting (Wood & Middleton, 1975). In the collaborative groups within this study, where students learned from a knowledgeable other, the perception of study participants was positive. Study participants' perception of PBL was that it was beneficial for learning and that the collaborative environment aided them in problem solving.

Study participant interview responses regarding grouping of students revealed that most believed group dynamics, more so than gender, was important when considering how to group students. Many of the study participants placed more emphasis on ability rather than on gender. However, my observation coupled with interview responses showed that gender may be an issue in classes where ability levels are low. Lower-functioning groups, especially for females, may fare better when grouped by ability and same-gender due to the reluctance of females to participate when gender grouping is mixed.

Experiential Learning Methods Such as PBL

The explorative nature of experiential learning combined with the social aspect that it provides makes teaching methods such as PBL a viable alternative for "at-risk" students, particularly females because it meets the social needs of these students (Cerezo, 2004). Experiential teaching methods such as PBL offers peer support, acknowledgment, and continued

reinforcement of existing knowledge as well as assistance and assurance in assimilating and synthesizing information (Lambros, 2002).

The PBL method allowed students to learn material through the co-construction of knowledge collaboratively. Learning in this type of environment also translated into deeper understandings of the concepts for the study participants. This method of teaching not only taught the concepts, but it also showed students how to learn, which is consistent with research by Savery and Duffy (1995).

With PBL, students were presented with the problem first, rather than with a traditional method where the relevant concept was taught and then applied to a problem. During the study, study participants: (a) examined and defined the problem; (b) explored what they already knew about underlying issues related to it; (c) determined what they needed to learn and where they could acquire the information and tools necessary to solve the problem; (d) evaluated possible ways to solve the problem; (f) solved the problem; and (g) reported on their findings. The PBL prompts varied in length; some were only one class period while others took multiple days to complete.

Learning outcomes and skill development that study participants experienced during their PBL sessions included (Nilson, 2010): working in teams, managing projects and holding, leadership roles, oral and written communication, self-awareness and evaluation of group processes, working independently, critical thinking and analysis, explaining concepts, self-directed learning, applying course content to real world examples, researching and information literacy, and problem-solving across disciplines.

Students who struggle in subjects such as mathematics often bear the burden of learning in a vacuum. In a traditional teaching setting, students have to understand the lesson that has been taught via whole group instruction, and then independently perform by completing pre-determined questions where a single solution is the only answer. This is a major undertaking for students considered at risk because they may stumble over basic facts, which become roadblocks to completing the assignment. However, with a collaborative setting, these roadblocks are diminished as students share information enabling them to complete their work.

According to the participants in the present study, PBL provided them with a teaching method that allowed students to explore concepts within a safe environment where questions could be asked and answers given from peers. This open exchange of information allowed students to gain validation of what they thought to be correct and also to gain helpful information when they were wrong. Students who lacked certain basic facts could research or collaborate with group members in order to complete the task.

Study participants found that the open-endedness of PBL was also appealing as the pressure of having to find a single correct answer was gone. Study participants said PBL was engaging and cited the fact that they could collaborate with peers, using a method of their choosing, and find suitable solutions to the problems.

Meeting the Needs of "At-Risk" Students

Students who are considered at risk have most likely endured years of failure and discouragement (Gamoran, 2003). These students may not be well served with traditional teaching methods, which are usually teacher-centered and where memorization of facts is the norm. Traditional teaching methods often fail to show the relevancy of concepts being taught,

which translates to a reduced level of interest and motivation. Students need to understand why learning a particular concept is important and how it will be relevant in their life.

Based on my observations and interviews from the present study, it is beneficial for these students to be able to co-construct knowledge with their peers rather than working independently without help from their peers. These students benefited when they worked in a collaborative group setting to problem solve. The social aspect should not be discounted as it serves an important role in the lives of students at this age. Cultivating peer relationships during the teenage years is something that female students place a great deal of emphasis on and can be used in collaborative settings to aid their learning.

This collaborative process with methods such as PBL benefited the students in multiple ways such as developing critical thinking skills, problem-solving skills and revealing relevancy of concepts with application of concepts to real-world situations. Study participants expressed their satisfaction with collaborative academic settings citing instances where they could rely on peers when they were uncertain of what to do. Other reasons given to show that PBL helped to meet the needs of study participants included being able to be part of the group, collectively forming a solution to the problem, and learning by watching others.

Gender Differences in Learning

Female study participants were asked, "Did you notice the girls having any difficulties with the boys when learning math with PBL" and males were asked the same question re-phrased to pertain to them. The males did not perceive any issues in working with the females; however, this was not the perception of female study participants. Females stated answers to this question such as, "…the girls worked only with the girls and the boys only worked with the other boys."

Another female stated that in her group she noticed several issues such as other female students afraid to ask questions for fear of how the male students might react.

This disparity between the perceptions of the genders was noteworthy; males saw no issues whereas, three out of the four female study participants perceived issues that hampered their learning. Notes from my field journal, as well as answers given by females in other similar questions during interviews, triangulated and confirmed this finding.

Males and females seem to be socialized differently in terms of their assessment of situations and perceptions of issues. Bevan (2001) found that when males succeed at mastering an individual mathematical concept, they tend to generalize this success to being good at math as a whole whereas females do not. Females tend to focus on the negative aspects such as any errors in their performance with mathematics as confirmation that they have little or no capacity to learn mathematics (Bevan, 2001).

The biggest gender difference in learning that I saw—based on triangulation of data in the form of field notes, interview responses, and prior research findings—was that males needed very little evidence of concept mastery to boost their self-efficacy. Males, given the slightest amount of encouragement or success, often became over confident in their abilities. Females did not seem to focus on what they did correctly, only what they could not master, and every mathematical concept that they failed to master added weight to their belief that they were poor math students.

The females seemed to be their own worst critic; they held on to these failures and used them as proof that they were not good at mathematics. The females appeared to see the glass half empty while the males saw the glass half full. Males interpreted each success, as proof that they

could do well in mathematics and females committed each failure to memory as a reminder that math was not their best subject.

Many females lack confidence in mathematics and this may be due in large part to cultural influences. Unfortunately stereotypes still exist, and the one regarding females and inferior mathematics performance is common. Society unwittingly fosters this misconception by portraying professions that require strong mathematic backgrounds such as scientists, engineering, and others as male professions (Dubetz & Wilson, 2013).

Females also tend to discard what they perceive to be baseless praise regarding their successes in mathematics (Else-Quest, Hyde, & Linn, 2010). If females do not feel comfortable and confident that they can reproduce the problem-solving process and get a correct answer, then no amount of praise will change what they believe regarding their mathematical abilities. I observed evidence of this during the study when female students were not satisfied with just a comment of "good job;" instead, they wanted to know why they were right and would it work out every time if they repeated the process.

Another observation was that the females, for the most part, unlike males, were not as judgmental. They were always willing to help those who are struggling. Their motto seemingly was, "Leave no one behind." The female study participants were caring and compassionate and wanted to see their friend succeed. I also observed that they displayed more empathy for the students who just "didn't get it." Male study participants, on the other hand, found it difficult to see past wanting to be first or to win. The competitive drive with males was very apparent and, in general, they did not seem to have the desire or patience to help students who were struggling.

Recommendations

PBL is an inquiry-based method of learning that requires students to think critically and problem solve. This method of learning is beneficial to most students because it encourages social as well as academic development. PBL incorporates collaborative learning situations with creative problem-solving scenarios that are designed to pique the interest of students. During PBL, students are active participants in their learning as opposed to passive recipients of inert information.

Social Skills

In order for collaborative teaching methods such as PBL to be effective, five basic elements of cooperation should be present (Johnson & Johnson, 1989). The five elements include; (a) positive interdependence, (b) individual accountability, (c) face-to-face promotive interaction, (d) social skills, and (e) group-processing.

Positive interdependence and positive goal interdependence should be established when groups are formed. Students need to understand that the group members are linked in such a way that everyone in the group needs to succeed. One way to establish this is through mutual goals and rewards. Teachers can set rewards for certain goals that are met such as saying, "If everyone passes with an 85 or better, everyone will be rewarded with 15 minutes of I-pod time."

Individual accountability is important because this prevents the group from letting one student do all of the work for the group. This can be achieved by assessing each of the group members individually, selecting one group member's work to represent the group, or have the students perform activities such as think-pair-share (Johnson & Johnson, 1989).

Face-to-face promotive interaction is the act of encouraging and promoting the success of others in the group. Praising, supporting, helping, assisting, or encouraging each group member's effort to learn can achieve this. Interpersonal skills are increased when group members become involved with helping one another learn. When students explain the nature of the problem or orally explain to one another how to problem solve, they are building their interpersonal skills.

Social skills are necessary when working in groups. Without proper knowledge and use of social skills, collaborative learning can be severely compromised (Johnson & Johnson, 1989). The lack of social skills in collaborative grouping is evident when: (a) group members seek to allow one student to do the work, (b) high-ability members take over for their own personal gain at the expense of others, (c) good workers decrease their efforts to avoid being labeled the sucker of the group. The act of placing the students in groups and telling them to work together will not produce the goal of a cohesive and collaborative educational setting (Johnson & Johnson, 1989).

Students must be taught how to work collaboratively by using social skills. Social skills include keeping up with the pace of the group, using quiet voices, contributing to the group's work, criticizing ideas without criticizing group members, asking probing questions, encouraging others, and requesting reasoning for answers (Johnson, Johnson, & Holubec, 1988).

Teachers can teach social skills by following the suggested series of steps (Johnson & Johnson, 1989). First, teachers need to show students the relevancy of learning social skills. One way to do this is to show students how they will benefit from using these skills. Teachers should identify the skill and explain it via posters and bulletin boards. Second, teachers need to convey

to students when and how to use the skill. This can be done through a T-Chart where the students list the skill and then what the skill looks like and what it sounds like. For further clarification, teachers can model the skill (Johnson et al., 1988). Next, mastery of the skill can be gained by having students role-play the skill with one another. Mastery may take time and teachers will need to be persistent in encouraging students to use the skill. Frequent cues will need to be given to encourage students to use the social skills consistently.

The next step is group processing, which includes making the students aware of their progress and usage of learned social skills. Asking students to reflect and discuss their use of a particular skill can do this. This practice will allow students to see where improvement is needed. An example of this would be to have the group perform a processing task where they are asked, "Name two things your group did well and name one thing that needs improvement." These types of processing tasks will increase students' interpersonal skills as well as small-group skills and achievement (Johnson & Johnson, 1989). Finally, students need to become comfortable with social skills by practicing them long enough to progress through the stages of awkward enactment, role-playing, mechanical use, and automatic use of the skill (Johnson & Johnson, 1989).

Teacher feedback on social skill usage is also extremely helpful for students (Johnson & Johnson, 1989). Teachers can also set up an incentive plan for students and positively reinforce the usage of the skills when they are observed during collaborative group work.

Social Skills Implementation

One of the main issues teachers may point out when considering a collaborative teaching method such as PBL is the difficulty in getting students to work together. Specifically, issues such as personality conflicts, one student doing all of the work, or other off-task behaviors cause teachers to question whether using a teaching method such as PBL is going to be productive or effective.

Teachers who are interested in using teaching methods such as PBL should research how to best teach, model, and implement social skills prior to the start of teaching collaboratively. Once the collaborative groups are formed, teachers can monitor student progress on the content as well as the usage of social skills. As previously mentioned, a good way to encourage student usage of social skills is to offer incentives by rewarding students when you see them practicing social skills.

Teachers can also set up a point system for students, which can be rewarded to individuals, the group, or the whole class. There are other ways to monitor the usage of social skills such as having student monitors who record the frequency with which students use social skills (Johnson & Johnson, 1990). Another strategy for implementation of social skills is to focus on one social skill per week. Teaching social skills to students may help to alleviate some of the common issues teachers encounter with students working in groups.

Best Use of PBL

PBL is a good resource to use to encourage inquiry-based, experiential learning. However, based on the observations made during the present study, and the preparation time needed to use PBL, it is my recommendation that PBL may be best suited as a supplement rather than the sole

method of teaching. Additionally, it is time consuming to find quality PBL prompts for very specific mathematical concepts. There are more PBL resources on the Internet each year, but it takes time to sort out the quality prompts from the poor prompts. I plan to use PBL at least two times per week in my classroom as a supplement to other student-centered methods.

For teachers who may be implementing PBL for the first time, it is advisable to give the students a tutorial on PBL. Students are not used to learning this way, and it is a bit of an instructional shock for them. They simply cannot imagine that you, their teacher, are not going to tell them each and every single step to take.

The first few PBL problems need to be more simple and short-term rather than the long involved problems that take several weeks to complete. A good starting point for the PBL beginner would be the Three Act series of PBL problems (Schettino, n.d.). These problems allow the teacher, or guide as well as the students, to acclimate to the instructional change while still learning content.

It cannot be stressed enough how important it is to use quality PBL problems. Problem selection should take into account whether the problem incorporates creativity and engages the students. Ideally, PBL problems should pique student curiosity, which is a tremendous vehicle for cultivating intrinsic motivation in students. Take the time to find PBL problems that strike a chord with your students and their gender and personal interests, and it will likely pay off with higher student engagement. I saw this firsthand with the PBL problems that I used. When the problem was personally interesting to the students, there was excitement within the classroom; however, if the problem was irrelevant to the students, their engagement suffered.

Grouping Students

The way in which you decide to group students matters with PBL. Because you as the teacher are most familiar with the personalities and work ethics of your students, you need to make decisions based on which students will work best with one another. This advice sounds like I am stating the obvious; however, with PBL, this is especially true. Students will have to brainstorm, and in the process, will have to generate and share ideas. Sometimes ideas work perfectly, and then sometimes an idea is not so great, but this is the brainstorming process. The group members need to be respectful enough of each other to get past ideas that will not work and listen to the ideas that will work, even when both are presented by the same student. In other words, just because a student presented an idea that was not good in one instance, does not mean that they will never have good ideas, and their group members need to understand this idea. Social skills that pertain to critiquing another group member's work—criticizing the idea and not the person—need to be implemented in these situations (Johnson & Johnson, 1989).

Female students may be insecure when presenting ideas, especially low-achieving females. Thus when grouping these students, special attention should be paid to the personalities and the group dynamics. If female students who historically do not perform as well in mathematics are grouped with dominating personalities, they will likely be reluctant to contribute to the group, which may limit or diminish their learning experience. Students who are confident in their abilities are not as vulnerable and may handle being grouped with bolder personalities.

Based on my observations in the present study, I believe that females who are considered at risk would benefit more from same-gender grouping, because they are much more inhibited with mixed-gender groups. It was apparent to me, and several of the students who were interviewed,

that students placed at risk would benefit more from same gender groupings because this situation appeared to be much more productive than mixed-gender groupings. The only caveat to this would be female students who are in higher functioning mathematics classes. Higher functioning female students may be less inhibited with mixed-gender groups because of their past successes in mathematics. Each individual group dynamic is different, and this study pertains to students who have struggled with mathematics, and therefore my opinion, based on observations and student interviews, is relevant only to students considered at risk. Grouping these students this way may allow them to work freely and voice their ideas without fear of jeopardizing their self-esteem.

Professional Development

Tutorials need to be given to the students to prepare them for this new approach to learning. Furthermore, teachers also need to prepare. Some teachers may find it difficult to hand over control of learning to the students, but this is what PBL requires. As a teacher, within PBL, our role changes. We become a guide. Our new job is to help students develop learning goals and then guide them toward these learning goals that they have set. We can steer them in the general direction, but genuine PBL is exploratory and inquiry based.

If a teacher is serious about teaching with the PBL method, then they really need to learn this method rather than trying to "wing it." There is an established protocol for this teaching method, and there is a rational behind the protocol. Teachers interested in implementing this method should understand it prior to using it in order to use PBL properly. Due to the nature of this type of learning, which is inquiry based, students are going to ask some deep questions that the

teacher may not expect. Therefore, teachers need to be prepared by being very well versed in the concepts being taught.

One of the first points that teachers should understand about PBL is that it is not the same as project-based learning. These two terms are not to be used interchangeably (see table *Problem-based verses Project-based*, page 37). There are distinct differences between the two such as being based on fiction or reality. PBL uses a fictional scenario whereas project-based uses real problems from around the world such as the water shortage in Africa or polluted streams in the community. Project-based learning incorporates several subjects and is interdisciplinary in nature while PBL is most often centered on a single subject. Other differences can be found in the final product. Project-based learning usually requires a tangible product or performance whereas PBL requires a presentation of a solution to the scenario prompt.

Future Research

The present study allowed the voice of students considered at risk to be heard regarding their perceptions of an effective PBL teaching method for learning mathematics. It is imperative that we understand how to motivate and build the self-efficacy of these and other math students placed at risk of failure by traditional teaching methods. Our society needs individuals who will be able to fill jobs in the work place that require low to high tech skills. These individuals will need to be able to work as a team, think critically and, most importantly be effective problem solvers (Carnevale, Smith, & Melton, 2010). These are some of the qualifications that fortune 500 companies will look for when hiring individuals for employment vacancies (Carnevale et al., 2010).

There is a shortage of research with middle grades female mathematics students and experiential teaching methods such as PBL. More research needs to be done in this area to find ways to close the gender gap in STEM related disciplines. Finally, since the present study shows that the perceptions of "at-risk" students are favorable to teaching methods such as PBL, there needs to be more research done for middle-grades mathematics students who are considered at risk because these transitional students are the most vulnerable. These students are at a pivotal point and need to be supported with effective teaching methods.

The importance of social skills cannot be underestimated when considering collaborative teaching methods such as PBL. Placing students in groups and expecting them to work together flawlessly is not realistic (Johnson & Johnson, 1989/1990). For that reason, I would also recommend that teachers strongly consider teaching social skills prior to the start any collaborative learning situation. Therefore, it is my recommendation that teachers include the implementation of social skills in order to make the collaborative groups more effective.

Significance

The importance of this study lies in the fact that we need to understand how to best meet the learning needs of students placed at risk of failure. It is valuable to the field of curriculum studies because it sought to investigate an equitable teaching method as an alternative to traditional gender-biased teaching methods, which limit the potential achievement of females and other "at-risk" students in mathematics education. Teaching methods that empower our students to experience the relevancy of mathematical concepts, increase the chances of their success in school and life. The significance of understanding which mathematics teaching methods students

perceive to be most effective in terms of learning, motivation, and gender have far reaching consequences for our technological society.

Society as a whole is affected in a multitude of ways, not the least of which is the cost to society associated with high student dropout rates. Teaching methods that empower students who are most at risk of failure in disciplines such as mathematics benefit our communities by having lower taxes, reduced crime rates, reduced spending on public assistance, and health care (Tyler & Lofstrom, 2009). Another possible benefit of this research is bringing increased awareness to the underrepresentation of females in higher-level mathematics classes and career fields and identifying an alternative teaching method that appears to boost their participation in both.

Closing Thoughts

There are those who hold the fixed belief that aptitude for mathematics is an inborn trait and, hence you are either inherently capable at mathematics or inherently incapable of learning mathematics. Unfortunately, sometimes parents pass this misguided belief on to their children. Several times during open house at school, I have had parents explain to me, "I was never good at mathematics and my child is not either, and I will be happy if she can just pass." These low expectations further convince the student that they, indeed, will never do well at mathematics. It also reinforces the ill-advised belief that math is not something at which you can apply some added effort and thereby improve, but instead, you are either born with this ability or not.

Many students considered at risk carry with them a very low opinion of their ability to do math, and this perceived inability is based on their previous poor performance in math classes, which has accumulated over a period of years. Years of struggle and eventual failure leave an indelible mark on students' self-efficacy and provide evidence for self-limiting beliefs.

Our job, as educators, is not only to impart knowledge to students, but also to help them see that they have the ability to receive and use this knowledge. Helping students to build confidence in their mathematical ability with experiential learning methods such as PBL is crucial especially when trying to motivate students placed at risk by traditional teaching methods. Research tells us that confidence in one's ability to succeed in mathematics is an intrinsic part of success and motivation (Boaler, 2003).

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APPENDIX A

PBL Observation Protocol

Once each week, the teacher will conduct a 45-minute observation of the female and male students during a PBL math class for behavioral, oral, or written signs of learning, motivation, and gender differences. A minimum of three class observations will be conducted. Student learning, motivation, and gender differences will be rated based on the following scale: 0 = not observed, 1 = minimal, 2 = to some extent, 3 = to large extent. The teacher will further describe in what ways the observations of learning, motivation, and gender differences were exhibited during math class based on behavioral, oral, or written signs.

1a. "At-risk" seventh-grade female students during PBL math class exhibited signs of

learning.

Circle one: 0 = not observed, 1 = minimal, 2 = to some extent, 3 = to large extent

Describe in what ways:

1b. "At-risk" seventh-grade male students during PBL math class exhibited signs of

learning?

Circle one: 0 = not observed, 1 = minimal, 2 = to some extent, 3 = to large extent

Describe in what ways:

2a. "At-risk" seventh-grade female students during PBL math class exhibited signs of

motivation (e.g., confidence, interest, comfort)?

Circle one: 0 = not observed, 1 = minimal, 2 = to some extent, 3 = to large extent

Describe in what ways:

2b. "At-risk" seventh-grade male students during PBL math class exhibited signs of

motivation (e.g., confidence, interest, comfort)?

Circle one: 0 = not observed, 1 = minimal, 2 = to some extent, 3 = to large extent

Describe in what ways:

3. "At-risk" seventh-grade students during PBL math class exhibited signs of gender

differences?

Circle one: 0 = not observed, 1 = minimal, 2 = to some extent, 3 = to large extent

Describe in what ways:

APPENDIX B

Student Interview Questions

In what ways do "at-risk' seventh-grade students who have been involved with PBL math classes perceive changes in their learning processes?

1. After using PBL in our class, what do you think about PBL?

2. Has PBL helped you in learning math?

   [If yes] How has it helped you?

   What did you learn?

   [If no] Why do you think that it was not helpful for your learning?

3. How do you like working with a group in PBL?

   [Liked working in a group] Why did you like working in a group?

   How did working in a group help you learn?

   [Don't like group] What did you not like about working in a group?

4. How does the PBL method of learning math compare to other methods of learning math that teachers have used in the past with you?

5. Which did you like better, the way you were taught prior to PBL or the PBL method? Why?

6. Do you think PBL helps to develop a student's problem-solving abilities?

   [If yes] In what ways?

   [If no] Why was it not more useful to you?

   How could we change it to make it more useful to you?

In what ways do "at-risk" seventh-grade students who have been involved with PBL math classes perceive changes in their motivational processes (e.g. confidence, interest, anxiety)?

1. How do you feel about participating in class after your experience with PBL?

2. Do you like math?

    [If no] Did your experience with PBL cause you to dislike math or did you dislike it prior to PBL?

    [If yes] Did your feelings change due to your experience with PBL?

3. Did PBL motivate you to learn math?

4. Compared to other classes where you solved problems in math, did you feel more or less comfortable with PBL?

    [Comfortable] How did PBL make you feel more comfortable?

    [Not comfortable] In what ways was it uncomfortable?

    How could we make it more comfortable for you?

5. Complete this sentence: —The biggest difference in math class between now and before my PBL experience is…

6. How has PBL affected your belief that you can/can't find the answer to a problem?

7. Do you feel more confident after using PBL?

    [More confident] How did it help your confidence?

    [Less confident] Why didn't it help your confidence?

    How can we change it to build your confidence?

In what ways do gender differences influence the perceptions of learning and motivational processes by "at-risk" seventh-grade students who have been involved in PBL math classes.

Questions for Girls

1. Do you think the girls would have <u>learned math better</u> with PBL if our class were all girls or learned math better with girls and boys together? Why?

2. Do you think the girls would have <u>felt more comfortable</u> learning math with PBL if our class were all girls or felt more comfortable learning math with girls and boys together? Why?

3. Do you think the girls would have <u>been more interested</u> in learning math with PBL if our class were all girls or more interested in learning math with girls and boys together? Why?

4. Do you think the girls would have <u>felt more confident</u> learning math with PBL if our class were all girls or felt more confident learning math with girls and boys together? Why?

5. Did you notice the girls <u>having any difficulties</u> with the boys when learning math with PBL? In what ways (if any)?

Questions for Boys

1. Do you think the boys would have <u>learned math better</u> with PBL if our class were all boys or learned math better with boys and girls together? Why?

2. Do you think the boys would have <u>felt more comfortable</u> learning math with PBL if our class were all boys or felt more comfortable learning math with girls and boys together? Why?

3. Do you think the boys would have <u>been more interested</u> in learning math with PBL if our class were all boys or more interested in learning math with boys and girls together? Why?

4. Do you think the boys would have <u>felt more confident</u> learning math with PBL if our class were all boys or felt more confident learning math with boys and girls together? Why?

5. Did you notice the boys <u>having any difficulties</u> with the girls when learning math with

6. PBL? In what ways (if any)?

APPENDIX C

IRB Approval

To: Deborah Bowers

From: Office of Research Services and Sponsored Programs
           Administrative Support Office for Research Oversight Committees
           (IACUC/IBC/IRB)

Initial Approval Date: 02/22/2016

Expiration Date: 01/31/2017

Subject: Status of Application for Approval to Utilize Human Subjects in Research –
           Expedited

After a review of your proposed research project numbered **H16290** and titled **""At-Risk" Seventh-Grade Students' Perceptions of Problem-Based Learning in Mathematics,"** it appears that (1) the research subjects are at minimal risk, (2) appropriate safeguards are planned, and (3) the research activities involve only procedures which are allowable. You are authorized to enroll up to a maximum of **8** subjects.

Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that the Institutional Review Board has approved your proposed research. Description: This study intends to discover whether after seventh-grade students' involvement with PBL, they perceive changes to their motivational processes and their learning processes.

If at the end of this approval period there have been no changes to the research protocol, you may request an extension of the approval period. Total project approval on this application may not exceed 36 months. If additional time is required, a new application may be submitted for continuing work. In the interim, please provide the IRB with any information concerning any significant adverse event, **whether or not it is believed to be related to the study**, within five working days of the event. In addition, if a change or modification of the approved methodology becomes necessary, you must notify the IRB Coordinator prior to initiating any such changes or modifications. At that time, an amended application for IRB approval may be submitted. Upon completion of your data collection, you are required to complete a *Research Study Termination* form to notify the IRB Coordinator, so your file may be closed.

Sincerely,

Eleanor Haynes
Compliance Officer

APPENDIX D

List of Codes Used in Transcript

Perceived Changes in Learning

1. Perceptions prior to PBL male positive

2. Perceptions prior to PBL male negative

3. Perceptions prior to PBL female positive

4. Perceptions prior to PBL female negative

5. Perceptions after PBL male positive

6. Perceptions after PBL male negative

7. Perceptions after PBL female positive

8. Perceptions after PBL female negative

Perceived Changes in Motivation, Comfort, Interest, Confidence, Anxiety and Concentration.

1. Motivation male/female increase

2. Motivation male/female decrease

3. Confidence male/female increase

4. Confidence male/female decrease

5. Interest male/female increase

6. Interest male/female decrease

7. Anxiety male/female increase

8. Anxiety male/female decrease

9. Concentration male/female increase

10. Concentration male/female decrease

Gender Differences/ Influence of Perceptions of Learning

Gender differences positive

Gender differences negative

Gender differences neutral

<u>Grouping</u>

Grouping positive

Grouping negative

Grouping neutral

Grouping same gender

Grouping mixed gender

<u>Mixed grouping</u>

Confidence m/f increased/decreased

Anxiety m/f increased/decreased

Interest m/f increased/decreased

Concentration m/f increased/decreased

Motivation m/f increased/decreased

<u>All Male/ All Female</u>

Confidence m/f increased/decreased

Anxiety m/f increased/decreased

Interest m/f increased/decreased

Concentration m/f increased/decreased

Motivation m/f increased/decreased

APPENDIX E

Frequency Table

Mprior neg	12	
Mprior pos	1	
Fprior neg	13	
Fprior pos	5	
Mafter pos	37	
Mafter neg	3	
Fafter pos	33	
Fafter neg	4	
Gen pos	4	
Gen neg	2	
Gen neutral	2	
Gpos	18 female/ 27 male	
Gneg	9 female/0 male	
Sgen	18 female/4 male	
Mgen	11 female/17 male	
CODE for individual	INCREASE	DECREASE
Motivation male—Mot ma	8	
Motivation female—Mot fe	9	
Confidence male—Conf ma	29	
Confidence female—Conf fe	26	
Interest male—Int ma	8	

Interest female—Int fe	8	
Anxiety male—Anx ma	2	
Anxiety female—Anx fe	4	
Concentration male—Concen ma	4	
Concentration female—Concen fe	3	2
CODE GROUPS MIXED	INCREASE	DECREASE
Confidence male mixed—Confi ma mix	6	
Confidence female mixed—Confi fe mix	3	7
Interest male mixed—Int ma mix	1	
Interest female mixed—Int fe mix	0	

APPENDIX F

PBL Prompts

I figure that most people in the U.S. eat a Peep or multiple Peeps during the Easter season. I know some people can't stand Peeps. Other people think they're great. There are even Peep eating contests that seem to not make the contestants too sick. Peeps are known for being an Easter candy, but now Peeps are made and available year round. **How many Peeps do you think are sold for Easter?**

1. Make a guess that you think is too low:

2. Make a guess that you think is too high:

3. Guess the number of Peeps that you think are sold each year:

4. By considering a little more information, lets see how your guess compares to an educated estimate and the actual amount. What information would be helpful to determine the number of Peeps sold in a year? List your ideas and some of the ideas from your class below.

5. Now that you have some ideas about what information would be helpful, your teacher will provide you with a little more information that might help. List this information below. Use the information to estimate the number of Peeps sold in a year. Show all your work and reasoning below.

6. Lets take a random sample of the class to get an idea of our estimates. Your teacher will gather ten estimates. Record each of these estimates in the table below:

Student Estimates for Peeps Sold in a Year
Find the mean estimate:

7. At the end of this activity your teacher will give you an actual approximation of the number of Peeps sold for Easter. How did the mean of the estimates compare to the actual approximate number of Peeps sold for Easter?

Peeps hints and solutions

This activity is a delightful investigation intended to get students and teachers to loosen up a little and appreciate how just considering a situation might lead you to a very reasonable approximation.

Too often students think that there is only one answer that is right and that the method for approaching that solution is also limited to the "correct" approach. Surely this fear of experimenting and guessing leads to math anxieties and the fear to reason and experiment.

Enjoy the discussion. Add information when you are asked or when you would like to. See how close your mean estimation comes to the actual solution. Pretty marvelous math!

Let's experiment here with different sorts of approximations.

Here is some useful information that you can dole out to your class.

- There are 315,542,788 million people in the U.S.
- There are roughly 7 billion people on Earth.

- *Just Born* (the company the makes Peeps) produces enough Peeps in one year to circle the earth twice.
- The Earth's circumference is 24,901 miles or 40, 075 KM.
- A Peep is around 2 inches or 5 cm long.
- On average 5.5 million Peeps are produced each day.

Solution according to *Just Born* = About 700 Million Peeps a year are sold at Easter time.

ake a look at the picture. What do you notice? What do you wonder? Fill in the table below with your noticings and wonderings.

Snow!

What I've noticed.	What I wonder.

Unless you have been living under a rock you have probably heard of the coffee shop Starbucks. Starbucks serves coffee drinks, beverages and treats in locations all over the world. Have you ever been to a Starbucks? Do you have a favorite Starbucks drink? I like many of their drinks, but I never know which drinks are healthier than others. I also wonder if the type of milk I get, or whether or not I include whipped cream, really makes a nutritional difference. In this activity we will take a closer look at these questions, but first let's estimate how many drinks Starbucks sells each year.

Doing some online research I have found the following information:
- Roughly 75% of Starbucks sales are from beverages.
- In 2010 Starbucks had about $10,700,000,000 in sales.
- A typical drink at Starbucks costs about $2. I chose $2 because I am guessing that Starbucks sells more of their cheaper drinks than their more expensive drinks. I also picked it because it's a lot easier to work with then two dollars and change.

1. Using the above information find a rough estimate for the number of drinks that Starbucks sells in one year. Show how you found your estimate below.

In the table below you will find nutritional information on some popular Starbucks drinks. The nutritional information below represents a 16 oz drink with whole milk.

Drink	Calories	Fat (grams)	Carbs (grams)
Iced Coffee with Milk	50	2.5	3
Hot Chocolate	300	9	47
Caffé Latte	220	11	18
Mocha Frappuccino Blended Beverage	260	3.5	54

2. According to the table, which drink appears to be the healthiest of the four choices? Why?

3. According to the table, which drink appears to be the least healthy of the four choices? Why? Is a certain type of beverage the healthiest choice for everyone? For every diet?

4. I see the fat content in each drink, but I am not really sure if that is a lot of fat or not. After doing some additional research I found that based on a 2000 calorie diet, one should have a maximum of 65 grams of fat per day. About what percent of your day's fat comes from each of the drinks in the table (if you have not yet learned about percent or haven't used them in a while, then try finding a rough estimate or express relationship as a fraction)?

5. The data in the table gives nutritional information for 16 oz drinks. Starbucks also sells a "tall" 12 oz drink. Assuming that the amount of calories, fat and carbs are proportional to the number of ounces in a drink, about how many calories, grams of fat and grams of carbs should you expect in a 12 oz hot chocolate?

Besides what type of drink I order, I also wonder if I should worry about the type of dairy products I have added to my drink. Does it really matter what type of milk I have in my Starbucks drink? What about the whipped cream? To get a better idea I have gathered data on two different popular Starbucks beverages.

In the table below you will find the nutritional information for a 16 oz (they call it a "grande", I call it a medium) Starbucks Caramel Frappuccino.

Dairy:	Calories	Fat (grams)	Carbs (grams)
Nonfat Milk	240	0	56
2% Fat Milk	250	2	56
Whole Milk	260	3	55
Whole Milk with Whipped Cream	390	15	61

In this table you will find the nutritional information for a 16 oz Caffe Mocha.

Dairy:	Calories	Fat (grams)	Carbs (grams)
Nonfat Milk	220	2.5	42
2% Fat Milk	260	8	41
Whole Milk	290	12	40
Whole Milk with Whipped Cream	360	19	42

6. What do you notice? Which dairy item has the greatest impact on the nutritional value of your drink? How many calories, grams of fat and carbs does this dairy item add to the Frappuccino? The Mocha?

7. I recently stopped getting whipped cream and whole milk in my Caffe Mocha. I now get a Caffe Mocha with 2% milk and no whipped cream. I get this drink about three times per week. How many grams of fat have I eliminated from my diet each week by not getting whole milk and whipped cream? How many grams of fat am I eliminating from my diet per year by making this dietary change?

8. One of the unhealthier options on the Starbucks menu is the "venti", or large, Peppermint White Chocolate Mocha with whole milk and whipped cream. It has 700 calories, 27 grams of fat and 99 carbs. About what percent of a typical daily 2000 calorie, 65 grams of fat and 300 grams of carbs diet does this drink make up?

9. Now that you have completed this activity what advice would you give a friend who is health conscious and enjoys getting drinks at Starbucks? What should you (or your friends) keep in mind so that you can still enjoy Starbucks while making healthy choices?