Academic Engagement and Achievement in High School Mathematics.

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Abstract

The question addressed in this quantitative action research study was: In high school Mathematics is there a correlation between the level of academic engagement and the level of academic achievement? It was hypothesized that if students are held accountable for their learning by being encouraged to be engaged in class activities and to complete all work assigned to them, they would achieve higher marks on unit tests. The purpose of this study was to determine if there is a correlation between the level of engagement and the level of achievement. Three types of measures were used to collect data on the level academic engagement in Grade 10 and 11 Mathematics classes. One measure was based on teacher/researcher observations of the participants’ level of participation in class activities. A second measure was assignment completion based on such criteria as neatness, thoroughness and timeliness. Rubrics were created based on educational research to aid in consistency when scoring these measures. The third measure of academic engagement was attendance records. Summative assessments in the form of unit tests and final exams were used as measures of achievement. Measures of central tendency and regression analysis were used to explore the quantitative data collected for levels of student academic engagement and level of achievement. The evidence suggested that for the participants of this study there was a weak, but positive correlation between the level of academic engagement and academic achievement in their high school Mathematics classes.
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Chapter One: Introduction

Purpose of the Study

The purpose of this study was to examine the relationship between high school Mathematics students’ level of academic engagement in their learning and their level of achievement. High school Mathematics was selected for this study because it is important for students to demonstrate their highest level of comprehension in Mathematics to enable them to maintain all their options for future endeavors. I have been a teacher for close to 30 years. I started my career teaching full time Physical Education and over time transitioned into full time Mathematics. I have been a teacher of Mathematics for over twenty years at the high school level, teaching grade nine through to Calculus 12. In Physical Education it was easy to observe the level of student participation. I took pride in keeping the students active and involved in their learning and development. As I moved into a classroom with four walls instead of a big open field, I almost thought it would be easier to monitor my students’ engagement in their learning, but that was not the case. By high school, many students had developed techniques to avoid my attention and to make it look like they knew what they were doing or that they were working when they were not. Many students seemed to have developed the attitude, ok teacher, go ahead and try to teach me. I didn’t accept passiveness in my Physical Education classes and I wasn’t going to accept it in my Mathematics classes. I didn’t want the passive students to feel I was punishing them for not being active learners; I wanted them to feel they were missing out on something and if they became actively engaged they would get more out of the class. I wanted my students to feel accountable to me and to their classmates, but most importantly to be accountable to themselves as learners.
I have noticed that students benefit when a learning environment is created where strong work habits and perseverance are expected and become the norm. Students seem to appreciate when guidelines are set in place to help them take responsibility for their learning. It is my role as teacher to motivate and engage the students and share my passion for learning. It is my responsibility to provide a learning environment that meets the needs of all the learners but the students also have the responsibility to be engaged in their learning to reach their academic potential.

Some students have difficulty with organizational skills or maturity level as they transition to high school. Some students have not yet developed the pre-requisite Mathematics skills to be successful in Mathematics. To help all learners reach their potential in Mathematics the learning environment needs to be a place where students are motivated and engaged in their learning. The purpose of this study was to investigate the importance of students being engaged in their learning. Through this study, I was seeking to discover if there was a correlation between the level of student engagement and the level of student achievement.

**Justification of the study:**

Mathematics is an essential subject in the industrialized world. It is one way of understanding, interpreting and describing our world (British Columbia Ministry of Education, 2008). Zwaagstra (2011) and Stinson (2004) support the notion that Mathematics is a critical filter to economic access, full citizenship, and higher education. Students need to do the best they can in their Mathematics classes as the skills are essential in the work place and necessary foundations for success in many university programs. Achievement level at the end of grade 10 is a determining factor for the Mathematics pathway a student will follow to meet their graduation requirements (British Columbia Ministry of Education, 2008). In grade ten there are
two pathways for Mathematics. Foundations and Pre-calculus Mathematics 10 leads to college and university, but Apprenticeship and Workplace Mathematics does not meet the pre-requisites for all post-secondary programs. Mathematics can be considered a gatekeeper, since poor mathematics skills can keep a student out of rigorous mathematics classes, diploma tracks and the job market. It is an obligation for the public school system to ensure every student has the opportunity to learn the skills required for university level mathematics courses (Zwaagstra, 2011). In Canada as in the United States there are a growing number of remedial mathematics courses being taught at the college level because students were unprepared for university level mathematics (Wilson, 2011; Zwaagstra, 2011).

Research suggests that to help students achieve higher levels of understanding in Mathematics they need to be motivated and engaged. Burks, Heidenberg, Leoni, and Ratliff, (2009) address the concern that a lack of motivation occurs with greater frequency in Mathematics students compared to students of other subjects. This supported the qualitative research by Vaughn (2012) that suggested if students feel confident and experience success, they begin to feel more confident and become more successful in Mathematics. Teachers need to create an environment where the students feel engaged, motivated, and confident in their ability to succeed. Within this environment, students need to take responsibility for their learning and be academically engaged (Dunleavy, Willms, Milton, & Friesen, 2012). According to Hume (2011), motivation is the precursor to engagement and engagement is a prerequisite for competence. “For the learning experience to be successful, students must combine commitment to the task with engagement” (Brown, 2009, p.5).

There appears to be support for correlating academic engagement with academic achievement. Finn (1993) stated, “student engagement in school and class activities is an
important and essential antecedent of successful achievement outcomes” (p. 266). More recently Archambault, Janosz, and Chouinard, (2012), claimed, “youth who are cognitively engaged, that is, who are willing to invest time and efforts in domains such as mathematics and science, achieve better outcomes in those domain-related activities” (p. 319).

Researchers have become increasingly interested in understanding how teachers, and especially teachers of mathematics, can promote their students’ cognitive engagement and achievement in school. Generally there are three categories of student engagement. The two categories that reflect being engaged in school are school or institutional engagement, and social or heart engagement. The category that reflects being engaged in learning is intellectual or mind engagement (Dunleavy et al., 2012; Hume, 2011). Attendance, effort and completing homework are the three measures of student engagement that have been shown to be related to higher marks in Mathematics, Language Arts and Science (Dunleavy et al., 2012).

**Research Question and Hypothesis**

The research question was: In high school Mathematics is there a correlation between the level of academic engagement and the level of academic achievement? I hypothesized that if students are held accountable for their learning by being encouraged to be engaged in class activities and to complete all work assigned to them, they would achieve higher marks on unit tests. The purpose of this study was to determine if there is a correlation between the level of engagement and the level of achievement. I believed it was the role of a good teacher to keep students accountable and to motivate them to be engaged in their learning. This research question was an action research question as the results could be used to reflect on ways to help improve our students’ achievement level.
Definition of Terms

Academic engagement, for the purpose of this study, involved a combination of two types of student engagement. One type of engagement was reflected in whether the student was an engaged member of the class or learning community indicated by them contributing to class or group discussions and activities. The other was the student’s engagement in their own learning and was reflected in their Mathematics learning behavior. Did they listen and take notes? Did they do their assignments and correct errors? Did they ask questions? Did they arrive with the proper supplies? Did they have good attendance patterns? Alternate terms such as intellectual engagement and cognitive engagement are used by other researchers (Dunleavy et al., 2012; Hume, 2011; Willms, Friesen, & Milton, 2012) to refer to this concept. Helme and Clarke (2001) support the idea that cognitive engagement can be observable in classroom situations.

Academic achievement for the purpose of this study was based on results of summative evaluation in the form of unit testing and the final examination.

Brief Overview of Study

This study took place in a Central Vancouver Island school district where there are two high schools that enroll grades nine to twelve. I have taught Mathematics in both of the high schools for over a decade each but the study took place in the one school that I was teaching in at the time of this study. The data collection for this study took place in semester one while I taught Foundations and Pre-calculus Mathematics 10 to one class, Foundations Mathematics 11 to another class and Pre-calculus 11 to two classes.

Consent forms (Appendix A) were sent home with students explaining the purpose of the study and asking for student and parent/guardian consent to permit the student to be a volunteer participant. A promise of confidentiality was made to the recruits. It was explained to them that I
would not know who volunteered for this study until after the course was over and their grades had been assigned. Recruits were assured that their names would never be mentioned in the study. Consent forms were collected by a colleague in the Mathematics department and held until after final marks were submitted for the semester. Data was analyzed after the completion of the course and after final marks had been assigned.

Regular classroom practices were established for the first three units of the course. All the students were new to me so time was needed to learn student names and become familiar with their learning styles and work habits. The students also needed time to become familiar with the regular classroom practices, to become more comfortable in the learning environment and to build trusting learning relationships with fellow students and with me as their teacher. Data was collected during units four through seven.

Three measures were used to collect data on the level of students’ academic engagement: observations of behavior and participation in class activities, assignment completion and attendance. Measures of academic achievement were the results on the unit tests and the final exam. At the end of the course, after the final marks had been submitted, academic engagement measures were compared with the academic achievement measures for consenting students. Patterns and trends were observed, not just overall averages. A quantitative approach was used to determine the levels of correlation between students’ academic engagement and their achievement level in Mathematics.
Chapter 2: Background and Review of Related Literature

The Importance of Academic Achievement Levels

Education has always been important but according to Wiliam (2011) academic achievement is important more now than any other time. Wiliam (2011) used educational research to support that raising educational achievement needs to be a national priority. He provided evidence that people with higher levels of educational achievement are healthier, live longer, contribute more to society and earn more money. The benefits to society include “reduced criminal justice costs, reduced health care costs and increased economic growth” (Wiliam, 2011, p. 1).

Zwaagstra (2011) and Stinson (2004) support the notion that Mathematics is a critical filter to economic access, full citizenship, and higher education. Mathematics is an essential subject in the industrialized world. It is one way of understanding, interpreting and describing our world (British Columbia Ministry of Education, 2008). According to the “Premier’s Technology Council” report (2010), functional numeracy along with literacy, are the most important skills and attributes needed for a 21st century learner. The report claims that numeracy is critically important. “Going beyond the mere mechanics of mathematics or arithmetic, numeracy is the ability to understand how to apply mathematical concepts to problems solving and to everyday life.” (p. 9). Learners need to “develop as numerate people in order to cope efficiently with the demands of their everyday lives.” (p. 9). According to Kemp and Hogan (2000), there seems to be international agreement that numeracy should be an important focus of schooling because numerate students are better able to learn at school and are better equipped for their everyday lives and their lives post schooling.
Mathematics as a Gatekeeper

The concept of Mathematics being viewed as a “gate keeper” has persisted since the time of Plato over 2300 years ago (Stinson, 2004). The level at which students demonstrate their understanding of the concepts in Foundations and Pre-calculus Mathematics 10 helps determine the Mathematics pathway they will take in grade 11 and 12. The senior Mathematics course selection plays a critical role in determining which post-secondary and career paths are open to them. It is important for students to strive for their highest potential achievement in their math classes since poor mathematics skills can keep a student out of rigorous mathematics classes, diploma tracks and the job market. They could be denied the opportunity to enter careers in such fields as engineering, medicine, finance and sciences. Zwaagstra (2011) supports the importance of providing the opportunity for all students to graduate with solid math skills. He points out that many entry-level jobs require students to have the ability to perform basic mathematical computations. Mathematic skills are essential in the work place and necessary foundations for success in many university programs. Achievement level in Mathematics is used by many universities, colleges, and trades programs as part of their entry requirements. Even more emphasis is put on the importance of high math marks in highly competitive programs such as sciences, economics and engineering. In Canada as in the United States there are a growing number of remedial mathematics courses being taught at the college level because students were unprepared for university level mathematics (Wilson, 2011; Zwaagstra, 2011). “The public school system has an obligation to ensure every student has the opportunity to learn the skills required for university level mathematics courses” (Zwaagstra, 2011, p. 5). Stinson (2004) questioned how to transform gate-keeping Mathematics from an exclusive instrument to an inclusive instrument for empowerment. One of the reasons I undertook this action research was
to find support for the need to encourage students to be intrinsically motivated to learn. If I could show that there was a correlation between academic engagement and achievement perhaps it would help students to accept responsibility for themselves as learners. In turn, this may help them to attain higher levels of achievement in Mathematics and allow them have more choices in post-secondary and career goals.

**Engagement and Achievement, and Self-regulation**

A review of literature suggests that being motivated and engaged does help students achieve higher levels of understanding in Mathematics. Research has shown that if students are engaged substantively and behaviourally, acquiring skills, achievement gains follow (Akey, 2006, Finn 1993). Brown (2009) argued that students’ emotional and behavioral engagement in school and class activities is of critical importance. Wiliam (2011) summarized that “high-engagement classroom environments appear to have a significant impact on student achievement” (p. 80). Cooper (2011) stated that “engaged students learn, disengaged students don’t” (p. 50). Brown (2009) claimed that engagement is a predictor of student success and quoted Seeley (2004), president of the National Council of Teachers of Mathematics, “Student engagement leads to learning for more students than we have ever reached before” (as cited in Brown, 2009, p.9) This is not a new philosophy. Finn (1993) reported that “student engagement in school and class activities is an important and essential antecedent of successful achievement outcomes” (p. 266). This current study compared measures of academic engagement and measures of achievement to determine if there can be considered to be a correlation between the level of a student engagement and the level achievement in high school Mathematics. Fredricks, Blumenfeld and Paris (2004) suggested that when measuring engagement to predict academic success, some researchers may combine the types of engagement in their studies as the
“conceptual distinctions are blurred because similar items are used to assess different types of engagement” (p. 69). Researchers Weiss, Carolan and Baker-Smith (2009) were able to construct a composite measure of student engagement using seven variables that encompassed both sociological and psychological properties. To develop their composite measure they surveyed teachers, students and parents on topics ranging from teacher experience and teachers’ belief about students’ ability, to the students’ school preparedness and their academic friends, to the parents’ level of education and socio economic status.

My review of research indicated there are generally three categories of student engagement (Willms et al., 2012; Hume, 2011; Dunleavy et al., 2012; Fredricks et al., 2004) although researchers use slightly different terms to identify them. One category, social or emotional engagement, involves a student’s sense of belonging at the school. This includes their level of involvement in school clubs, teams or other events. The second category of student engagement is academic or behavioral engagement involving such things as the level at which the student follows school rules, concentrates and perseveres, attends class and completes homework. The third category of student engagement is intellectual or cognitive engagement. This category includes the level at which the student is psychologically invested in their learning. Do they go beyond expectations? Are they self-regulated? According to Dunleavy et al. (2012), Willms et al. (2012), and Hume (2011), the students’ level of involvement in class activities can be an indicator of engagement in their learning. They are engaged when they are involved in class discussions, attentive during instruction, and a productive and cooperative group member. Hume (2011) stated that,

researchers find engagement challenging to define and even more challenging to measure. For teachers, doing so is less of a problem – with just a little classroom
experience, many of us are confident that we can accurately determine whether a student is engaged or disengaged, virtually at a glance (p. 6).

The level of students’ engagement can also be reflected in teachers’ records of assignment completion. Are assignments completed in a timely and thorough manner or are they disorganized, uncorrected or incomplete? Willms et al. (2012) claim that students’ participation in the formal requirements of schooling, for example, completing assignments and attending classes can be indicators of academic engagement. Methods of measuring levels of academic engagement for this current study were derived from recent research on student engagement. According to Dunleavy et al. (2012) attendance, effort and completing homework are the three measures of student engagement that can be related to higher marks in Mathematics. The current study used these three measures to collect data for levels of students’ academic engagement.

While providing an engaging and supportive learning environment, learning professionals need to guide the students to accept responsibility for their own learning and to be intrinsically motivated to reach their academic potential. Students who do not believe they have the ability to do math can be taught skills that help them develop a growth mindset. Dweck (2006) describes how growth mindset, as opposed to fixed mindset, can help students take charge of their learning and motivation. She defines growth mindset as the “belief that your basic qualities are things you can cultivate through your efforts . . . everyone can change and grow through application and experience” (p. 7). Students with growth mindset study to learn and understand not just to memorize. They learn that skills and achievement result from their commitment and effort. Students need to become self-regulated learners and develop meta-cognitive skills to optimize their acquisition and use of knowledge (Schneider & Stern, 2010). Self-regulation is an integral part of knowledge acquisition. The concept of intrinsic motivation and self-regulation has been
around for decades. Zimmerman (1990) discussed the impact self-regulation and intrinsic motivation has on student achievement. He noted that students who display initiative, intrinsic motivation and personal responsibility achieved more academic success. He claimed that, self-regulated students are distinguished by their systematic use of metacognitive, motivational and behavioral strategies; by their responsiveness to feedback regarding the effectiveness of their learning; and by their self-perceptions of academic accomplishment (Zimmerman, 1990, p. 14).

Burks et al. (2009) address the concern that a lack of motivation occurs with greater frequency in Mathematics students compared to students of other subjects.

**Pedagogy and Quality of Teaching**

Researchers have become increasingly interested in understanding how teachers, and in particular mathematics teachers, can promote their students’ cognitive engagement and achievement in school. Istance and Dumont (2010) summarized that two key conclusions of learning sciences researchers are that effective learning needs to be recognized as the core activity in the learning environment, and that the learners are the core participants. Wiliam (2010) states that teachers are responsible for engineering a learning environment, both in its design and operation that ensures learning takes place. Pedagogy and quality of teaching can have a significant impact on the level of students’ intellectual and academic engagement, and level of achievement. Supportive teachers have a positive impact on the development of student engagement and confidence in their abilities. Supportive does not mean lowering expectations to make the course easier on the students. “Lowering standards just leads to poorly educated students who feel entitled to easy work and lavish praise” (Dweck, 2006, p. 193). Numerous studies (Akey, 2006; Archambault et al., 2012; Vaughn, 2012) found when the teachers set clear
and high expectations for the learners, more learning took place and students developed a higher
perception of their competencies in math. Achievement in high school mathematics is
influenced by the students level of engagement in school and by the students own perception of
the academic competence (Akey, 2006). Akey’s (2006) study suggests that when teachers have
high expectations, believe students have the ability to learn, and take responsibility for students’
learning; students are more engaged, feel more competent while they are learning, learn more,
and use few avoidance strategies when facing difficulties and perform better.

Brown (2009) and Vaughn (2012) each completed studies that addressed the students’
perceptions of their attitudes towards Mathematics. Brown (2009) completed qualitative
analysis of research data to better understand the students’ perception of engagement in high
school Mathematics classes. The following three broad questions guided this investigation:

1. What are students’ practices and beliefs concerning student engagement in the
   secondary mathematics classroom?

2. What are the patterns of engagement in the secondary mathematics classrooms?

3. What are the interactions between the students in the secondary mathematics
   classroom and primary contexts that affect students? (p. 8)

Interviews and questionnaires were used to collect information, and part of the study involved
behavioural observations of grade 11 and 12 students of Mathematics. This current study also
included teacher observation of student behavior as one method of collecting data on level of
engagement. Findings from Brown’s (2009) results showed four conditions that affected
students’ patterns of engagement in mathematics classrooms. They included: (a) moods,
feelings and /or physical conditions, (b) effort, (c) behavioral engagement including
attentiveness and help seeking skills, and (d) approach to instruction (p. 126). “For the
learning experience to be successful, students must combine commitment to the task with engagement.” (Brown, 2009, p. 5)

Vaughn (2012) found factors that impact learning originate from the students’ own attitudes about mathematics. Vaughn (2012) used a qualitative approach in a phenomenological study to address the perceptions that middle school mathematics students may have about themselves in relation to the study of mathematics. Interviews, focus groups and several forms of unobtrusive data such as journal entries and student records were used to develop an understanding of what students experienced and how they experienced it. The results indicated that the participants considered their Mathematics teacher as having the greatest effect on their feelings about studying mathematics.

Past experiences with mathematics teachers, their past academic performance in mathematics, and their own beliefs about their mathematical abilities had the greatest impact on their current feelings and attitudes about the study of mathematics.

(Vaughn, 2012, p. 95)

Vaughn (2012) summarized that although teaching the mathematical concepts are extremely important, the manner in which they are taught impacts student motivation and attitude towards Mathematics.

Another study that supports the relationship between quality of instruction and student achievement is “What Did You do in School Today?” (Dunleavy et al., 2012) This study is a national initiative of the Canadian Education Association (CEA) designed to enhance learning in middle and high school classrooms. It focussed on the concept of intellectual engagement. Data presented in this report included responses from 51,708 grade 6-12 students. The study used three measures of intellectual engagement: interest and motivation, effort, and quality
instruction. The results suggested that unlike language Arts and Sciences, the relationship between quality of instruction and high marks was considerably stronger in Mathematics. The study also indicated that attendance, effort and homework completion rates had the strongest relationship with higher marks in Mathematics, in that order. The study did not define the criteria used to determine the student’s marks but Dunleavy et al. (2012) questioned their results that indicated many students who demonstrated higher levels of institutional engagement such as attending class and completing their homework, were receiving higher course marks without, according to the survey results, being intellectually engaged. These students were being good at school and were being rewarded with better marks but were they actually learning? Akey (2006) argues that, “how engaged a student is in behavior associated with school success (such as doing homework and trying hard in school) plays a secondary but meaningful role in determining the level of mathematic achievement” (p. 18-19).

However, as Dunleavy et al. (2012) pointed out, if students are receiving high marks without being intellectually engaged, it is time to look at the marking criteria and adjust how grades are given and how achievement is measured. Using marks as an indication of achievement may have been a limitation in the Dunleavy et al. (2012) study as the marks for a course may have also included effort and work habits. This current study was designed to further research the link between intellectual engagement and academic achievement by using summative assessment results as measures of achievement, not the students’ overall Mathematics mark.

The study by Weiss et al. (2009) also used summative assessment for their measures of achievement through results on standardized Math 10 tests. Similar to this current study Weiss et al. (2009) conducted multilevel regression analysis comparing measures of engagement and level of achievement. With their very large sample size of 10,946 grade 10
students they were hoping to find a generalizable relationship between school engagement, mathematics achievement and school size with specific focus on cohort size. They did find a high correlation between these measures but due to the diversity of students’ needs they were not able to prescribe the ideal school size.

Summary

In summary, research and literature support the view that developing skills in Mathematics is important if not essential to succeed in the 21st century. It is important to achieve high marks in Mathematics to increase options and opportunities for future career paths and post-secondary programs. Research indicates that using supportive and engaging pedagogy in math classes helps to increase the students’ level of intellectual and academic engagement. In order to truly learn Mathematics, not just memorize steps, students need to accept responsibility for their own learning, be self-regulated. It is the intent of this study to investigate further if there is a correlation between the level of academic engagement and achievement in high school Mathematics.
Chapter 3: Procedures and Methods

Research Design

This study was designed to determine if there is any correlation between the observed level of student academic engagement and the level of academic achievement in high school Mathematics. The research design of this study was action research. According to Mills (2011), action research is about the willingness of a teacher to critically examine their teaching practices in order to improve or enhance their practice to benefit student learning. Since there is evidence to support the notion that higher achievement levels in Mathematics can increase post-secondary and career path opportunities (British Columbia Ministry of Education, 2008; Stinson, 2004; Wiliam, 2011; Zwaagstra, 2011) it is important to explore teaching practices that could help students attain high levels of achievement. Measurements of behavior and participation in class activities were scored subjectively based on observations. Quantitative research and analysis methods were used to examine if there was a correlation between level of engagement and level of achievement in the Mathematics 10 and 11 classes that I taught.

Sample

This action research study took place in Central Vancouver Island in a high school that enrolls grades nine to twelve. Participants were recruited from the four grade 10 and 11 Mathematics classes that I taught in the first semester. The classes were one Foundations and Pre-calculus Mathematics 10 class, one Foundations Mathematics 11 class and two Pre-calculus Mathematics 11 classes.

The research took place from September, 2013 to January, 2014. Of the 89 possible student recruits, 15 consented to having their results included in the study. Parental consent was
also received. Nine of the participants were in Mathematics 10, 3 students were in Pre-calculus 11 and 3 were in Foundations 11. There were 6 male participants and 9 female participants. The participants were between 15 and 17 years of age and represented a variety of socioeconomic and cultural groups common to the catchment area of the school. To assure anonymity, participants were coded randomly by Mathematics course and numbers were used in the data instead of student names. Students in the other Mathematics courses, Apprenticeship and Workplace Mathematics 10 and 11 were not invited to volunteer for the study as I did not teach either one of these courses in the semester in which data was collected.

**Instruments Used**

Fredricks et al. (2004) suggested that when measuring engagement to predict academic success, some researchers may combine the types of engagement in their studies as the “conceptual distinctions are blurred because similar items are used to assess different types of engagement” (p. 69). Similar to a study by Weiss et al. (2009), this current study used a composite measure of student engagement. According to Dunleavy et al. (2012) attendance, effort and completing homework are the three measures of student engagement that can be related to higher marks in Mathematics. The current study combined all three of these measures to collect data for levels of student engagement under the umbrella term, academic engagement. Attendance records were kept through British Columbia Enterprise Student Information System (BCESIS). A rubric was used (Appendix B) to score all students’ assignment completion effort on a six point scale from zero to five. Zero was given if the assignment was not completed before the unit test. (When determining grades for report cards, assignments were accepted up to the cut off day for mark entry without late penalties as directed by the school principal.) The criteria used in the assignment completion rubric were developed by this researcher based on years of
teaching experience. I also used a rubric (Appendix C) for consistency in scoring students’ participation and learning behavior during class activities. I developed the criteria for this rubric based on my 28 years of teaching experience as well as research by the “What Did You Do in School Today Series” (Dunleavy et al., 2012; Willms et al., 2012), and research by Cooper (2011) and Hume (2011). Criteria included such things as whether or not the student was involved in class discussions, were they an active member of small group activities, or did they isolate themselves? Did they start working on assignments promptly or did they procrastinate? Did they come to class on time with correct supplies and with a readiness to learn, and did they support the learning of fellow classmates?

Much of the recent research done on student engagement has been qualitative and involved surveys completed by students. The current research is quantitative and involves a collection of data based on teacher observations. Fredricks et al. (2004) commented on a number of studies that asked teachers to rate the students’ level of engagement in various classroom activities. Hume (2011) states that,

researchers find engagement challenging to define and even more challenging to measure. For teachers, doing so is less of a problem – with just a little classroom experience, many of us are confident that we can accurately determine whether a student is engaged or disengaged, virtually at a glance (p. 6).

I have been a teacher for close to thirty years and have been a teacher of grades 10 and 11 Mathematics for over twenty years. Reassured by the comments made by Fredrick et al. (2004) and Hume (2011), I felt qualified to collect data on student engagement in Mathematics classes through observation and records of assignment completion and achievement results.
Summative assessment results on unit tests and final exams were used as measures of achievement. Quantitative methods and multilevel regression analysis were used to examine the level of correlation between measures of engagement and level of achievement. These methods were also used in research by Weiss et al. (2009).

**Procedures**

Prior to gathering data, I sought and received approval from the Vancouver Island University ethics review board. Approval was then received from the superintendent of the school district and the principal of the school in which the study took place. During the third week of the semester I read the student recruitment script (Appendix D) to each class and talked to the students about action research. Students were given the opportunity to ask questions in class or confidentially after class. Parent Recruitment scripts (Appendix E) and consent forms (Appendix A) were sent home with students explaining the purpose of the study and asking for student and parent/guardian consent for the student to be a volunteer participant. Consent forms were collected by a colleague in the Mathematics department and held until after final marks were submitted for the semester. A promise of confidentiality was kept by coding the participants. Students were reminded occasionally throughout the semester to drop off the consent form in room 280.

It was normal daily routine in the Mathematics classes involved in this study to have the completion of daily assignments recorded and available for the students to check. It was also normal routine for summative unit tests to be completed at the end of each unit as well as a final exam at the end of the semester. The unit test and exam results were used as indicators of academic achievement.
There were seven to eight units taught in each Mathematics course. The average unit length was twelve lessons. Regular classroom practices were established for the first three units of each course. All the students were new to me so time was needed to learn student names and become familiar with their learning styles and work habits. The students also needed time to be familiar with the regular classroom practices, to become more comfortable in the learning environment and to begin building trusting learning relationships with fellow students and me. Data was collected from all students during units four through seven. The students were not aware of which units were being used for the study.

Collecting data on students’ effort completing daily assignments in a timely manner was a part of regular classroom practice (timely being defined as having the formative assignments completed before the summative unit test was given) For the purpose of this study the rubric (Appendix B) was used to assign a score to the effort. Expectations for assignment completion criteria were explained to all students. The rubric (Appendix B) was posted in the classroom. Students were given guidance to take responsibility to complete all tasks. Directions for each assignment were written clearly on the white board at the front of the class and a record of all assignments was posted on the wall at the back of the class. The record of completed assignments was attached to a coloured folder (different colour for each block) and the students were encouraged to check the folder often. I was as consistent as possible to motivate and instill in students the benefits of good work habits. For example students were kept in at lunch for help to complete assignments if patterns of incomplete assignments became apparent. Parents of students missing assignments were informed.
Observation records of student behavior were kept. Two or three times a week I observed and recorded the level of student involvement in class activities. A six point rubric (Appendix C) was used to assign a score. Attendance was taken daily and recorded in BCESIS.

Data analysis began after final course marks had been calculated and submitted to the school principal for report cards. Measures of central tendency and regression analysis were used to explore the quantitative data collected for levels of student academic engagement and level of achievement.

During the analysis of the data and the completion of the study, data was stored on a secure password protected computer. Data paper was locked a file cabinet in the home of the researcher. Upon completion of the study, all data will be stored in a secure location in the supervisor’s office at Vancouver Island University.

**Validity**

Attempts were made to try to improve the external validity of the study by recruiting participants from more than one grade and more than one Mathematics course with the intent of maximizing the size of the sample group. Also, I had over twenty years of experience teaching high school Mathematics enabling more consistent standards of identifying levels of academic engagement. Rubrics were created to also help ensure more consistency when subjectively scoring observations of students’ level of engagement in class activities and completion of assignments. Unit tests and the final exam were not significantly altered from the previous year as the teachers in the Mathematics department felt they were strong, reliable measures of student achievement. The grade 10 final exam was a standardized provincial exam.

As the teacher/researcher, I made efforts to consistently set high expectations for each student and held them accountable for completing assignments by frequently recording
completed assignments and reminding of past due work. Detentions were assigned for patterns of incomplete work to help students understand the importance of keeping up with assignments. Almost every class involved a form of partner or group work where each student was accountable to another student. These actions helped to improve the level of internal validity of the study as each student was given equal opportunities to demonstrate their level of engagement in their learning. Class routines were consistent in all units of the course. The students were not aware of which units were used in the study. Records of the three measures of academic engagement were kept for all students in my classes. To help prevent bias when recording observations I was unaware of the volunteer participants in the study until the students’ final marks were submitted to the principal.

Some limitations to the validity of this study are the extenuating circumstances that lead to students being disengaged in their learning or less engaged in their learning than they usually are. For example, there may be a family crisis at the time of the study or the student may have extended absences due to family vacations or health issues. Another limitation is that some students may have worked very hard in Mathematics and been very engaged in class activities but may have had difficulties grasping the concepts resulting in low achievement scores. The hypothesis suggested that their level of academic engagement could have resulted in higher achievement levels than if they had been less engaged.

Analysis Techniques

Measures of central tendency and variability were calculated for each of the three indicators of academic engagement: assignment completion results, observed participation levels in class activities, and attendance, and then compared to the indicators of academic achievement, unit test results and the final exam. The results were a reflection of any correlation that may exist
between student academic engagement and student academic achievement of the participants from four Mathematics classes in the particular school during the given semester and were not meant to be a generalization of a larger population.

Data was represented on graphs illustrating any correlation that may have existed between level of engagement and level of achievement in high school Mathematics. Bar graphs and scatter plots were used to represent relationships and variability. Values of $R^2$ were calculated to determine the predictability power of the models. Observations of trends in change over time were noted. Comparisons were made between individual students from the grade 10 Mathematics class, since that was the largest sample group. Data from all participants and all units were used for more general comparisons between level of engagement and level of achievement for this sample group of high school Mathematics students. The results were analyzed to attempt to interpret any correlation that may have existed. Recommendations for the need for further study were made as well as recommendations for improving teaching practices to increase student achievement in high school Mathematics.
Chapter 4: Findings and Results

Summary

The purpose of this study was to examine if there is a correlation between the level of students’ academic engagement and academic achievement in high school Mathematics. The research took place from September, 2013 to January, 2014 at a secondary school on Vancouver Island. The sample group was from four high school Mathematics classes including one Foundations and Pre-calculus Mathematics 10 class, one Foundations Mathematics 11 class and two Pre-calculus Mathematics 11 classes. Of the 89 students, 15 consented to having their results included in the study. To assure anonymity, participants were coded randomly by Mathematics course and numbers were used in the data instead of student names. Quantitative methods of data collection were used to score the students’ level of participation in class activities, their level of assignment completion and their attendance. Rubrics (Appendices B and C) aided in consistency of the first two types of measurement but some qualitative methods were needed as the scoring was subjective. Field notes were kept to describe or explain any extenuating circumstances that arose. Quantitative data analysis was used to determine any trends or correlations between the participants’ measures of academic engagement and the measures of achievement.

Quantitative Data Analysis

The quantitative research design included three measures of student academic engagement including records of teacher observation of student participation in classroom activities, records of assignment completion, and records of attendance. These measures were compared to the level of achievement based on unit test results. All measures were converted to be represented as percentages.

Based on my observations as the teacher/researcher, the level of student participation in class activities was recorded at least twice a week. A rubric (Appendix C) was used to score
these observations on a six point scale from zero to five. If a student was absent due to a school activity such as band, athletics or class field trip they were omitted from participation scoring that day and their percent was calculated based on days in attendance. If a student was absent for any other reason such as a family vacation, parent excused absence, or truancy, the score for participation that class was recorded as a zero.

The second measure of academic engagement involved scoring assignment completion. Normal classroom practices required students to submit completed assignments for completion marks with no penalty for being late. For the purpose of this study all student assignments during units four, five, six and seven were scored on a six point scale from zero to five. A rubric (Appendix B) was used to aid in consistency of scoring. A score of zero was given if the assignment was not submitted by the day of the unit test. Attendance, the third measure of academic engagement was recorded daily using the British Columbia Enterprise Student Information System (BCESIS).

The Foundations and Pre-calculus Mathematics 10 class was the only grade 10 class included in this study. The participants from that class will be referred to as the Grade 10 participants. There were attempts to review trends or patterns for individual participants from the Grade 10 participants since they represented 60% of the sample group. Twenty percent were Foundations 11 participants and the other 20% were Pre-calculus 11 participants.

Scatter plot graphs were created to investigate any correlation between the three measures of academic engagement and the measure of academic achievement, unit test scores, for all participants. For each relationship represented with a scatter plot, regression analysis was used to calculate the equation of the trend line and the $R^2$ value. The $R^2$ value is the coefficient of determination, or the predicting power of the model. When an $R^2$ value approaches ±1 it is an
indication that the variability (difference) of $y$ values can be explained by the variability of $x$ values. For this study that means that an $R^2$ measure of +1 indicated a positive direct correlation between the measure of engagement and the level of achievement and that 100% of the change in achievement level could be explained by the engagement measure level. Conversely less and less of the changes in achievement level could be explained by the changes in levels of engagement as the $R^2$ value approached 0.

The trend line represents the line of best fit between the data represented on the graph. It matches the trend or general pattern of the coordinates on the graph. The slope of the trend line is the coefficient (number in front) of the $x$ and can be an indication of the rate of change of the rise of the line compared to the horizontal run of the line. For the results of this study the slope of the trend line could be an indication of how the achievement results tend to rise or fall as the measure of academic achievement increases. Theoretically (and with an $R^2$ value close to 1) the greater the value of the slope, the greater the increase in achievement as the measure of engagement increased.

**Findings for All Participants**

Figure 1 represents the relationship between the observed level of student participation in class activities and the unit test results. The results are colour coded to represent each unit to help identify any changes over time. The equation for the trend line is $y = 0.1803x + 68.041$ and the $R^2 = .0286$ indicating an overall low level of correlation between participation in class activities and achievement level. One participant demonstrated low levels of engagement and low achievement in Unit 4 and 1 participant showed low engagement but high achievement in Unit 6. By Unit 7, 60% of the participants had participation in class activity levels of over 90% but there
was a range of achievement levels from 43% to 100%.

Figure 1: Participation in class activities versus unit test results by unit.

Figure 2 represents the relationship between participation in class activities and unit test results for all students colour coded by type of Mathematics course to investigate possible differences the level of engagement in class activities may have had in different grades and different types of courses. The equation for the trend line for the Grade 10 participants was $y = 0.2446x + 63.395$ and the $R^2$ value was .0882. The equation for the trend line for the Foundations Mathematics 11 participants was $y = 0.5434x + 32.383$ with an $R^2$ value of .1007. For the participants in Pre-calculus Mathematics 11 the equation for the trend line was $y = -0.0262x + 92.427$ and the $R^2$ value was .0003. The Pre-calculus 11 participants demonstrated a high level of academic achievement in most cases. The two lower scores on the unit tests still had high levels of participation scores. Participant 116 achieved a score of 57% on the unit 7 test but appeared to have an engagement level of 87%. Participant 115 also achieved a lower score on the unit 7 test but had a high engagement score of 100%. The Grade 10
participants showed the widest range in both variables. Although the predictability score was low for all classes, the Foundations 11 students showed the highest $R^2$ value at .1007. The slope of the trend line for the Foundations 11 results demonstrated the strongest rate of change between test results increasing as participation level increased.

![Figure 2: Participation in class activities versus unit test results by courses.](image)

The relationship of assignment completion versus test results was represented in both Figures 3 and 4. They are basically the same graph, however in Figure 3 the data was colour coded by units and in Figure 4 the data was colour code by type of Mathematics course. Both Figures 3 and 4 indicated the equation of the trend line for the assignment completion versus test results relationship was $y = 0.3051x + 59.826$ with an $R^2$ value of .2506. The .3051 slope of the trend line indicated a positive but gradual increase in test results as the assignment completion increased. The $R^2$ value indicated that if you wanted to predict the test results for all of the participants in this study, looking at their assignment completion rate would have given you a higher predictability power ($R^2 = .2506$) than looking at their level of participation in class activities model ($R^2 = .0286$). On the other hand, if you wanted to predict the test result for
participants in different courses based on assignment completion, Figure 4 illustrates the different predictability powers by course. The highest predictability power was found in the Pre-calculus 11 data with an $R^2$ value of 0.6924. The Grade 10 participants’ predictability power was much lower at $R^2 = .2398$. The predictability rate for the Foundations Math 11 was the lowest at $R^2 = .2032$.

Figure 3: Assignment completion versus unit test results by unit.

Figure 4: Assignment completion versus unit test results by course type.
Attendance records were used as a third measure of academic engagement. The results of the relationship between attendance and unit test results for all participants are represented in Figure 5. The $R^2$ value of 0.0017 and the slope of the equation for trend line, $y = 0.0644x + 78.057$ indicates very little, if any, correlation between attendance and unit test results for the participants in this study. Most participants had high attendance patterns. There was a wide range of unit test results.

![Figure 5: Attendance versus unit test results for all participants.](image)

Figure 6 represents the relationship between a calculated average of academic engagement and the final exam result for all participants. The average was calculated from the level of participation in class activities and the assignment completion scores. Since the $R^2$ value of attendance versus unit test results was .0017, attendance was not used in calculating average level of academic engagement for Figure 6. There appears to be a close link between measures of the combined average of academic engagement and the final exam results; however two participants had a difference of over 30% between a high engagement measure and a lower exam result. One participant had an engagement average at 50% with an exam result 23% higher.
Findings for Foundations and Pre-Calculus Mathematics 10 Participants

The largest sample group represented the Grade 10 participants. Attempts were made to enable closer observations of trends in engagement levels versus achievement levels by plotting individual participant results. Figures 7 and 8 shows how test results may be affected by each Grade 10 participants’ level of participation in class activities and/or their level of assignment completion. The four bar graphs in Figures 9, 10, 11 and 12 depict the results of both measures of academic engagement and the unit test results for each Grade 10 participant in each unit.

Participant 101 demonstrated consistently high test results and assignment completion but lower scores for participation in class activities. Results for participant 102 show some discrepancies. In the units with the highest test results participant 102 had the lowest assignment completion score but the highest level of academic engagement scores. Participant 103 demonstrated consistently high levels of academic engagement but test results varied from 53% to 95%. Participant 105 consistently demonstrated academic engagement levels and test results...
of close to 100%. Participant 108 had test results ranging from 70% to 90% with assignment completion scores of 50% to 60%, however participation in class activity scores were very high. The data suggests that the lowest test result occurred for participant 109 who also had the lowest assignment completion and the second lowest participation score. The trend for participant 109 was that test results improved in the units that academic engagement levels improved.

Figure 7: Grade 10 participants’ level of participation in class activity versus unit test results.

Figure 8: Grade 10 participants’ assignment completion versus unit test results.
Figure 9: **Unit 4** - Grade 10 participants’ results for participation in class activities, assignment completion and the unit test.

Figure 10: **Unit 5** - Grade 10 participants’ results for participation in class activities, assignment completion and the unit test.
Figure 11: **Unit 6** - Grade 10 participants’ results for participation in class activities, assignment completion and the unit test.

Figure 12: **Unit 7** - Grade 10 participants’ results for participation in class activities, assignment completion and the unit test.
The four Foundations and Pre-calculus Mathematics 10 units involved in this study may have had varying levels of difficulty. Table 1 represents measures of central tendency and the standard deviation of measures from Units 4 through 7. Figures 9, 10, 11 and 12 are bar graphs representing the results for each Grade 10 participant in each unit. It appears participants found Unit 6, the third one in the study, to be the most difficult. Mean test results in Unit 6 were the lowest at 77.9% with a standard deviation of 13.82. Participation in class activities was the lowest for this unit as well at 83.3% with a standard deviation of 19.46. Unit 6 assignment completion scores, however, were higher than two other units at 81.8% with a high standard deviation of 23.175. The last unit, Unit 7, appears to have been the least difficult for the participants based on mean scores and standard deviation for test results and participation in class activities; however, the assignment completion mean was the lowest of all four units.

Table 1

_Mean Scores and Standard Deviation for Each of the Grade 10 Units. (n=9)_

<table>
<thead>
<tr>
<th>Unit</th>
<th>PCA Mean %</th>
<th>PCA SD</th>
<th>AC Mean %</th>
<th>AC SD</th>
<th>Test Result Mean %</th>
<th>Test Result SD</th>
</tr>
</thead>
<tbody>
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<td>86.3</td>
<td>16.472</td>
<td>78.2</td>
<td>24.876</td>
<td>83.33</td>
<td>16.055</td>
</tr>
<tr>
<td>5</td>
<td>89.2</td>
<td>11.163</td>
<td>81.4</td>
<td>20.773</td>
<td>87.9</td>
<td>8.034</td>
</tr>
<tr>
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<td>83.3</td>
<td>19.46</td>
<td>81.8</td>
<td>23.175</td>
<td>77.9</td>
<td>13.82</td>
</tr>
<tr>
<td>7</td>
<td>89.8</td>
<td>13.871</td>
<td>75.1</td>
<td>24.085</td>
<td>89.7</td>
<td>8.935</td>
</tr>
</tbody>
</table>

_Note._ PCA=Participation in Class Activities. AC=Assignment Completion. SD= Standard Deviation
Chapter 5: Summary, Discussion and Conclusions

Summary

The purpose of this study was to examine any correlation between the level of academic engagement and the level of academic achievement in high school Mathematics. Participants were grade 10 and 11 students from a high school in Central Vancouver Island. Evidence from Stinson (2004), Wiliam (2011) and Zwaagstra (2011) suggest the importance of students’ achievement levels in Mathematics in terms of future post-secondary and career paths. This study was action research based with the intent of helping me as the teacher/researcher examine the results of my teaching practices to help improve student achievement levels in Mathematics.

This study used the influences of Hume (2011), Dunleavy et al. (2012), and Weiss et al. (2009) to measure levels of academic engagement. Three measures of academic engagement were recorded. One measure was based on teacher observations of participation in class activities. Completion of assignments and attendance records were the other two measures of academic engagement. Data was collected from the fourth through seventh units of each course. The main measure of achievement was unit test results but the final exam results were also acknowledged.

There were 15 participants in this study. Nine were in Foundations and Pre-calculus Mathematics 10, 6 were in Foundations Mathematics 11 and 6 were in Pre-calculus Mathematics 11. Results are specific to this sample group and not intended to be perceived as general results for the entire population of high school Mathematics students. Promises of confidentiality were kept by randomly assigning numbers to the participants but field notes were kept to help explain extenuating circumstances when analyzing the data. Records were kept on all students in all classes. Another teacher in the department collected signed consent forms. I was not aware of
which students had voluntarily consented to participate in the study until after final course marks had been submitted to the principal of the school at the end of the semester.

Quantitative methods using regression analysis and measures of central tendency were used to explore any correlation there may have been between the level of academic engagement and the level of academic achievement in high school Mathematics for the participants of the study. Overall there was a weak but positive correlation between the level of academic engagement and the level of achievement in Mathematics for the high school students who participated in this study.

**Discussion of Findings**

The results of this study imply for the participants there is generally a positive but weak correlation between the measures of academic engagement and achievement. Although the trend was towards higher scores on measures of academic engagement coinciding with higher test results, there were too many exceptions for this to be considered predictive. Many participants demonstrated high levels of participation in class activities but had low test results. A few students maintained high test scores even in the units where class participation was low or they did not complete all of their assignments.

The results of this study did support that engaged students learn. All of the participants demonstrated evidence of being academically engaged in their Mathematics and the results of their unit tests and the final exam indicated that learning had taken place. No disengaged students volunteered to be participants in the study and no evidence was collected to indicate disengaged students do not learn.

More specifically, the question of this study was to examine if students’ level of achievement was affected by students’ level of academic engagement through participation in
class activities, their level of assignment completion, and their attendance patterns. There was a trend of increased levels of participation in class activities (Figure 1) from the fourth unit to the seventh unit. Figures 1 and 2 indicated a weak positive correlation existed between the increased levels of participation and higher test scores. Two Pre-calculus 11 students had high participation in class activities scores but low test scores of 57% and 68%. The level of difficulty of the concepts in this unit could explain this discrepancy. It is possible that test results would have been even lower had the participants not been as engaged in their learning. This same argument could be used to possibly explain why in the entire sample group 6 participants with over 90% participation level achieved less than 70% on the unit tests. Four of these results were within the same unit. Field notes gave a possible explanation for why the participant with the lowest participation score earned almost 90% on the test for that unit. The participant missed 5 classes due to family vacation. The participant completed the assignments upon return.

Most of the Foundations 11 results trended towards higher participation levels coinciding with higher test results except for one Foundations 11 participant who had high participation results with low test results. Field notes indicated that during this unit the participant appeared to be in a better mood and seemed healthier than in previous units. She was more attentive and seemed more comfortable asking for help or clarification. According to Brown (2009) these are some of the conditions that affected students’ patterns of engagement in mathematics classrooms. Even though the participant was still having difficulty with the concepts on test day, she appeared to be feeling more confident and engaged in Mathematics. According to Vaughn (2012) students’ own beliefs about their mathematical abilities had the greatest impact on their current feelings and attitudes about the study of mathematics.
The model representing assignment completion versus unit test results for all participants (Figures 3 and 4) demonstrated a stronger predictability power \( R^2 \) of 0.2506 than the model representing participation in class activities versus test results (Figures 1 and 2) with an \( R^2 \) value of 0.0286. These values are both considered to be low, however when looking at the comparison between assignment completion and test result of the Pre-calculus 11 participants (Figure 4) there was a high predictability power of 0.6924. This could be interpreted to mean that 69% of the differences in test results for Pre-calculus 11 participants can be explained by the differences in assignment completion. Only 20% could be explained for Foundations 11 participants (Figure 4) and 24% for the Grade 10 participants (Figure 4). Perhaps by the Unit 7 in Pre-calculus 11 the students accept and understand the level of commitment needed to clearly understand the higher level concepts of Pre-Calculus 11. The students in Pre-calculus 11 may be more aware of the importance of their achievement level in the course as it is a pre-requisite course for many post-secondary programs. It also leads to Pre-calculus 12 which is a pre-requisite course for degrees in science, engineering and economics. The minimum Mathematics requirement for graduation is any of the three Mathematics 11 courses. The range of Foundation 11 participants’ academic engagement results and the achievement results may be an indication of the range of reasons students enrolled in the course. The students’ internal motivation to earn higher levels of achievement may depend on their personal goals involving Mathematics. A passing mark enables high school graduation. Higher marks may enable entrance to post-secondary programs that don’t require Pre-calculus Mathematics 11.

Overall, for the participants in this study, evidence suggests the ability to complete the assignment had a higher correlation with academic achievement than did the level of participation in class activities. For the participants in this study attendance did not appear to
Affect unit test results (Figure 5). The one participant who was on vacation completed the assignments. He also did well on the unit test.

When the Grade 10 results were analysed as a separate group (Figures 7 and 8) they demonstrated a wider range of results, possibly because they represent a wider range of student abilities and work habits. The students that will proceed to either Foundations 11 or Pre-calculus 11 are in the same Mathematics 10 course. Figures 9, 10, 11 and 12 reflect results for grade 10 students for each unit. Some participants were observed to be highly engaged when participating in class activities (Figures 1 and 2) but did poorly on unit tests. Others had low participation levels but did well on the test. One Grade 10 participant did well on unit tests, completed assignments thoroughly but was not a cooperative group member in class activities (Figure 4). Field notes indicated that another participant (108) struggled with completing assignments before the unit tests but was highly engaged in class activities. This participant needed extended time on the tests. The extra time did not always lead to high levels of achievement but by allowing extra time to finish the test the measure of achievement was likely more accurate.

Table 1, *Mean Scores and Standard Deviation for Each of the Grade 10 Units*, illustrated that in the Grade 10 Mathematics class Unit 7 had the highest mean test results (89.7%, SD of 8.9). Unit 7 was also the unit with the lowest mean assignment completion score (75.1, SD of 24.1) but the highest mean participation in class activities score (89.8, SD 13.9). The high correlation in this unit between the level of student engagement in class activity and achievement is worthy of further investigation. There was a large standard deviation for assignment completion. Did some of the weaker students start completing more assignments because they had a better understanding or more confidence in their ability to complete the assignment after being more engaged in class activities? Did the students with a clear understanding of the
concepts not bother to do the assignments because they didn’t feel they needed the practice? If the students are engaged in class activities and self-regulated enough to be sure they understand the concepts, do they really need to complete all of the assignments? These are all questions that warrant further study.

Although there was a range of results when comparing class participation and assignment completion there was a positive correlation between academic engagement and achievement in the high school mathematics participants. The results in the higher academic course seemed to indicate that higher levels of assignment completion led to higher test results. The results of the less academic courses tended to indicate that higher levels of participation in class activities led to higher test results.

**Limitations**

There were limitations to this study. I hoped that the sample group would have had more representation from Foundations 11 and Pre-calculus 11 classes. It should be noted that 17 of the 89 possible recruits were international students and none of them volunteered to be participants even though they talked to me about it and showed an interest. Thirteen of the international students were in Pre-calculus 11. The overall sample group represented a range of abilities but many had strong work habits causing the academic engagement measures be skewed higher. It is possible that the students with lower levels of engagement weren’t motivated enough to hand in their consent form. Gentle reminders were given throughout the semester.

I felt confident the unit tests were strong measures of understanding concepts from each unit, however some participants may have benefitted from other forms of summative assessment to determine achievement level. Another possible limitation was that the two main measures of academic engagement were subjective. A rubric was used to help with levels of consistency but
the reality of a high school classroom where I taught every block of the day without preparation time could have led to some inconsistencies in scoring. Had I known who the participants were during the duration of the study, time would have been saved and measures may have been more accurate as I could have reduced the volume of data collected, however confidentiality of participants would have been compromised.

Implications of Study and Suggestions for Further Research

The results of this study supported the hypothesis that students who were engaged in Mathematics class activities and who completed their assignments could achieve higher test scores. However, the results also showed that for the participants of this study, there was a wide range of achievement levels for students who appeared to be highly engaged. There was also a wide range of achievement levels for students who appeared to have low levels of academic engagement. This is an indication of the diversity of students in Mathematics classes. The diversity needs to be acknowledged and addressed. It is the role of a teacher to discover what it takes to motivate and engage each learner. As Wiliam (2011) pointed out it is the role of the teacher to *engineer* a learning environment where learning takes place. This study supports the research that indicates learning takes place when students are engaged learners. As Dumont et al. (2010) stated, learning needs to be the core activity in the learning environment and the learners are the core participants. Further study and research needs to be done on how to improve teaching practices so that students better understand their role as learners. There is also a need for further research regarding what leads students to become motivated and responsible learners. I have a role to provide a motivational and engaging learning environment and students have a role to be self-regulated and accept responsibility for their learning.
This action research study allowed me to critically examine an aspect of my teaching practices and to make recommendations for practices that could help improve student learning and levels of achievement in high school Mathematics. I found evidence that supported my hunch that engaged students learn. While going through this research process I also found a wealth of information supporting the importance of students doing well in Mathematics and developing a clear understanding of the concepts. Many researchers have completed studies on students’ perceptions of themselves as Mathematics students. All the research indicates that it is important that we as educators motivate students to be engaged in their learning. We need to be passionate about our subject and sensitive to the needs of our students. Quality of instruction is important in the high school Mathematics classes, even more so than any other subject to help our students attain high levels of understanding and achievement. I see a need for me to go out and share what I have learned with my colleagues. We need to work together to reflect and improve on our quality of instruction. A recommendation for practice is to research teaching principles and adapt practices to better meet the needs of all learners. There is a need for collaboration with colleagues and for educators to be engaged learners themselves.

At the beginning of this study the statement was made that since the time of Plato Mathematics has been considered to be a gate-keeper. Stinson (2004) questioned can we transform gate-keeping Mathematics from an exclusive instrument to an inclusive instrument? I believe that the key to the gate is developing intrinsically motivated and engaged learners, enabling them to reach their highest level of achievement in Mathematics. Will they follow the path of least resistance or feel confident enough to enter the pathway that involves perseverance, confidence and a joy of learning? We need to work together to find ways to keep the gate open as wide as possible for all learners.
References


Appendices

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Appendix A

Consent Form

Student Engagement and Achievement in Mathematics

In addition to being your child’s Mathematics teacher, I am a student at Vancouver Island University working to complete a Master’s Degree in Educational Leadership. As part of the program I am engaged in applied educational research which is designed to inform and improve my professional practice.

Your child is being invited to participate in this research because he/she is a student in my class. The purpose of this study is to examine any connection between the level at which a student is engaged in their learning and the level of their achievement in Mathematics. Research results will be presented in a written thesis to Vancouver Island University and a summary report will be made to the School District with recommendations for teachers of Mathematics at the middle and high schools. It is hoped that this will help me to continue building on strategies to encourage students to be fully engaged in their studies so they may reach their academic potential in Mathematics and to share these findings with other teachers.

It is normal classroom practice in this course to keep track of the following:

- Assignment completion.
- Level of engagement in class activities as observed by the teacher.
- Attendance.
Achievement results on unit tests and the final exams. Course expectations for participants and non-participants are the same. With your permission, your child’s results in these four areas will be used to explore the relationship between student engagement and student achievement. There are no extra activities involved for being part of this research. I am only asking for permission to use your child’s class records and results as data for analysis in my research. I may take journal or field notes throughout the course to record unexpected or extenuating events or circumstances that may impact the results of the study. These notes will be general in nature and will not contain any identifying information.

If you consent to allow your child’s records to be used in this study, please ask him/her to return a signed copy of this letter in a sealed envelope to another teacher from the Mathematics department who will lock them in a secure place. I will not know who consented to be a participant until after the final course marks have been submitted and I begin recording and analyzing the data.

Your child will not be identified by name in any reports of the study and there are no harms associated with your child participating in this study. Participation will be anonymous, until after the final marks for this course have been submitted. All records of your child’s participation in the study will be kept confidential. Study documents will be kept in a locked filing cabinet for five years in my office. Electronic data and results of this study will be stored on a secured computer with restricted access (password). Project data will be destroyed after five years.

This study is entirely voluntary. You or your child may refuse to participate or may withdraw from the study at any time, for any reason and without penalty.”

Even though you consent to your child’s participation, your child has the right to refuse to participate or to withdraw from the study on his/her own at any time, for any reason, and without penalty.

If you have any questions or desire further information with respect to this study, you may contact me, Mrs. Anne Pearce, Kwalikum Secondary, at 250-752-5651 ext. 161. Email: apearce@sd69.bc.ca, or my Supervisor, Dr. Rachel Moll, Faculty of Education, Vancouver Island University at 250-753-3245 x 2161, Email: rachel.moll@viu.ca
If you have any concerns about your treatment as a participant in this research, please contact the Vancouver Island Research Ethics Officer at reb@viu.ca or by telephone at 1-888-920-2221 (local 2665).

Please discuss this with your child. If you and your child consent to having their class records used as data in the study outlined above, please sign below on one of the consent forms and return it to a drop box provided in Mrs. Stefanek’s classroom 280. You may keep the other consent form for your own records.

Thank-you,

Anne Pearce

I have read the above form and give consent to include my child’s assessment results in this action research study.

_________________________________  ______________________________
(Parent Signature)  (Date)

_________________________________
(Child/Student Signature)
Appendix B

Rubric for Assignment Completion for Mathematics

<table>
<thead>
<tr>
<th>Score</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Assignment description top left of paper, name and date top right of paper. Neat, in pencil and showing appropriate steps and workings. Thoroughly completed, marked and corrected. Completed challenge question. Submitted by due date.</td>
</tr>
<tr>
<td>4</td>
<td>Assignment description top left of paper, name and date top right of paper. Completed in pencil and showing appropriate steps and workings. Thoroughly completed, marked and corrected. Attempted challenge question. Submitted up to two classes late.</td>
</tr>
<tr>
<td>3</td>
<td>Assignment description top left of paper, name and date top right of paper. Completed in pencil. Work is not neat or is poorly organized, not all steps are shown. Thoroughly completed but not marked or not corrected. Submitted more than two classes late but before detention was assigned for late assignments.</td>
</tr>
<tr>
<td>2</td>
<td>Assignment description top left of paper, name and date top right of paper. Completed in pencil. Completed after being assigned a detention for late assignments</td>
</tr>
<tr>
<td>1</td>
<td>Completed after numerous reminders and being assigned detention(s) for late assignments.</td>
</tr>
<tr>
<td>0</td>
<td>Assignment not completed before unit test.</td>
</tr>
</tbody>
</table>
Appendix C

Rubric for Observed Level of Engagement in Class Activities

<table>
<thead>
<tr>
<th>score</th>
<th>Description of observed behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Attentive, listening and responding to teacher and classmates. Punctual, and arriving with appropriate supplies. On task, attempting practice examples, taking notes, working on assignments, working cooperatively with others, persevering, seeking help when needed. Active member of group activities. Volunteers (demonstrates, share group’s ideas, writes on tablet or board, etc.)</td>
</tr>
<tr>
<td>4</td>
<td>Slow to start activity, notes, assignment, arranging group seating, but works well once task is started. Tries to work independently in group activities but joins in when reminded. Avoids asking questions. Doesn’t volunteer but readily does task when asked (demonstrates, share group’s ideas, writes on tablet or board, etc.)</td>
</tr>
<tr>
<td>3</td>
<td>Easily distracted but returns to task when reminded. Insufficient supplies but borrows what is needed from classmates. Late to class without a valid reason but participates well upon arrival. Resists contributing to group activities or discussions. Needs encouragement to contribute to group activities. Avoids answering questions orally.</td>
</tr>
<tr>
<td>2</td>
<td>Insufficient supplies and doesn’t take initiative to arrange for supplies. Late to class without a valid reason and disruptive or slow to task upon arrival. Easily distracted, disrupting learning environment, slow to return to task. Needs to be reminded to be a cooperative group member. Extended time out of classroom without a valid reason.</td>
</tr>
<tr>
<td>1</td>
<td>Actively disengaged for much of the class but on task occasionally. Playing games or watching videos on personal devise or texting during independent work time.</td>
</tr>
<tr>
<td>0</td>
<td>Absent. Actively disengaged or disrupting the learning environment. Playing games or watching videos on personal devise or texting during instruction or group activity time.</td>
</tr>
</tbody>
</table>
Appendix D

Student Recruitment Script

Study Title: Student Engagement and Achievement in Mathematics.

Principal Investigator: Anne Pearce.

In addition to being your teacher this year, I am also a student right now. I am working to complete a Master’s Degree in Educational Leadership at Vancouver Island University. As part of the program I am doing research to help improve how I plan and teach Mathematics to help students reach their academic potential.

The study I will be doing involves examining connections between the level at which a student is engaged in their learning and the level of their achievement in Mathematics. As students in my Mathematics class this semester, you are being asked to volunteer to be what is called a participant in the study. The good news for you is that you don’t have to do anything except give me permission to use your class results as data. There are no extra activities involved if you consent to participate. Being a participant, or not, will not affect your grade or my perception of you as I won’t even know you agreed to participate until after your final marks have been submitted. I will keep track of everyone’s assignment completion and test results, and I will observe and record your level of engagement in class activities as the course progresses. When the semester is over, I will open up the sealed consent forms and transfer the results on to data sheets. Your names will not be used in the study.

Each of you will take home a consent form. I will describe this study to your parents at parent night. If you choose to be a participant you and your parents are asked to sign the consent form
and return it to Mrs. Stefanek’s room (280). She will keep them in a secure place until I am ready to collect the data.

Do you have any questions you would like to ask? If you don’t want to ask in front of the whole class, feel free to talk to me later.

Now, let’s engage in some math!
Appendix E

Parent Recruitment Script

Study Title: Student Engagement and Achievement in Mathematics.

Principal Investigator: Anne Pearce.

In addition to being your child’s Mathematics teacher, I am a student at Vancouver Island University working to complete a Master’s Degree in Educational Leadership. As part of the program I am engaged in applied educational research which is designed to inform and improve my professional practice.

Your child is being invited to participate in this research because he/she is a student in my class. The purpose of this study is to examine any connection between the level at which a student is engaged in their learning and the level of their achievement in Mathematics. Research results will be presented in a written thesis to Vancouver Island University. It is hoped that this will help me to continue building on strategies to encourage students to be fully engaged in their studies so they may reach their academic potential in Mathematics and to share these findings with other teachers.

It is normal classroom practice in this course to keep track of the following:

- Assignment completion.
- Level of engagement in class activities as observed by the teacher.
- Attendance.
- Achievement results on unit tests and the final exams.

Course expectations for participants and non-participants are the same. With your permission, your child’s results in these four areas will be used to explore the relationship between student
engagement and student achievement. There are no extra activities involved for being part of this research. I am only asking for permission to use your child’s class records and results as data for analysis in my research. If you and your child agree to their participation, your child will be asked to return a signed consent form in a sealed envelope to another teacher in the mathematics department who will lock the forms in a secure place. I will not know who consented to be a participant until after the final course marks have been submitted and I begin recording and analyzing the data.

Your child will not be identified by name in the study and there are no harms associated with your child participating in this study. Participation will be anonymous, until after the final marks for this course have been submitted. All records of your child’s participation in the study will be kept confidential. Documents will be kept in a locked filing cabinet for 5 years in my home office. Electronic data and results of this study will be stored on a secured computer with restricted access (password).

This study is entirely voluntary. You/your child may refuse to participate or may withdraw from the study at any time, for any reason and without penalty.”

Even though you consent to your child’s participation, your child has the right to refuse to participate or to withdraw from the study on his/her own at any time, for any reason, and without penalty.