Exploring the Use of Blogging in Applied vs. Academic Mathematics Classrooms

by

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Abstract

Reports worldwide indicate that students are having difficulty with mathematics, specifically with their ability to problem-solve and communicate (EQAO, 2014; Muliis, Martin, Foy & Arora, 2012; OECD, 2012). This study investigated how blogging in grade nine applied and academic classrooms could be used to increase mathematical knowledge, communication and confidence. This study used a mixed methodology, with quantitative survey data and qualitative data from open-ended questions, performance tests, and blog analysis. Forty-eight participants (31 male, 12 female, 5 no response) in this study were grade nine students, aged 13-16 years old. Twenty-one students were enrolled in an applied mathematics program, and 27 were enrolled in an academic mathematics program. The results indicated students had a positive attitude toward blogging in mathematics class. Blogging had little impact on students' mathematical confidence, however the confidence scale was not specific enough to measure confidence by unit. Blogging increased mathematical knowledge, however they cannot be directly linked as other teaching strategies were used during the study. Mathematical confidence did not increase, as students lacked the requisite collaborative skills and the ability to scaffold their learning on the blog site. Academic mathematical communication was slightly higher overall.

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1. Introduction

1.1 Overview

Today's mathematics classroom must prepare students for their future roles in society, as mathematics is a fundamental skill needed in out daily lives (Boaler, 2008; Jordan, Glutting & Ramineni, 2010; Ku, Chen, Wu, Loa & Chan, 2014; Ministry of Education, 2005). However, many students are unable to link what they do in the classroom to their everyday lives therefore they do not see mathematics as useful (EQAO, 2014; Furner & Gonzalez-DeHass, 2011; Johnston-Wilder & Lee, 2010). Reports all over the world indicate that students are having difficulty with mathematics (EQAO, 2014; Mullis, Martin, Foy & Arora, 2012; OECD, 2012). The field of mathematics is an abstract area of study which students find challenging (Nehme, 2011). The Programme for International Student Assessment (PISA) reported that 32% of all participating students did not reach the baseline level 2 in the mathematic assessment (OECD, 2012). Only one in five students were able to solve the problem-solving questions on the PISA (OECD, 2012). Trends in International Mathematics and Science Study (TIMSS) reported that more countries demonstrated relative strengths in knowing mathematics, such as recalling and computing, but not in applying mathematical reasoning (Mullis et al., 2012). In 2013-2014, EQAO data from Ontario, the largest province in Canada, indicated 15% (academic level) and 49% (applied level) of grade 9 students failed to achieve the provincial standard in mathematics (EQAO, 2014). Grade 9 students performed least well on questions assessing the skill of problem-solving (EQAO, 2014). Carley (2011) adds that primary students in New Mexico are specifically lacking in the area of mathematical communication.

Limited ability to problem-solve, communicate and link mathematics to authentic tasks may be partially explained by the way students are encouraged to learn. As students travel through their educational journey, they learn to play the "game of school" where the primary focus may be biased toward memorizing facts, concepts and procedures to achieve good grades (Richhart, Church, & Morrison, 2011; Skemp, 2006). Children can acquire the belief that getting the correct answer is the most important part of learning and that working alone is best for success with limited emphasis placed on the learning process (Richhart et al., 2011; Whitin & Whitin, 2000).

According to Skemp (2006), there are at least two types of learning in mathematics: instrumental and relational learning. Instrumental learning is the memorization of facts and procedures, whereas relational learning involves selecting different strategies and skills to solve new, complex problems (Skemp, 2006). Although instrumental learning has the potential to increase self-confidence, as students can often get the correct answer more quickly, it does not allow students to develop a deeper understanding of the mathematical content (Baxter, Woodward & Olsen, 2005; Kostos & Shin, 2010). Some evidence suggests that students who follow an instrumental learning regime are less able to problem solve and think mathematically as they have not developed sufficient mathematical learning strategies and have limited opportunities for communication in the classroom (Borasi & Rose, 1989; Kostos & Shin, 2010; Richhart et al., 2011).

Mathematical communication, defined as "the process of expressing mathematical ideas and understanding orally, visually, and in writing, using numbers, symbols, pictures, graphs, diagrams and words" (Ministry of Education, 2005, p.16), has the potential to promote relational learning, as described by Skemp (2006). Researchers hypothesize that students are able to reflect upon and clarify their ideas, understanding of mathematical relationships, and mathematical arguments when they are encouraged to communicate (Ministry of Education, 2005). The ability to think, problem-solve, and communicate in mathematics does not come naturally, and educators play a big part in developing these skills within the classroom (Carley, 2011; Evans, 2002; McCrone, 2005).

Technology has the potential to support and enhance mathematical communication within the classroom and help build relational learning skills (Cheung & Slavin, 2013; Ellison & Wu, 2008; Ministry of Education, 2005). Technology has infiltrated numerous aspects of modern life, and the classroom is no exception (Brescia & Miller, 2006; Cheung & Slavin, 2013; Delen & Bulut, 2011). According to a 2008 study in the US, 83% of students aged 12-17 use the internet for communication regularly, 71% have their own cell phones, and 59% have their own computers (Cooper, 2012). Brescia and Miller (2006) report that 74% of teens use instant messaging as a major communication tool. Technology may be important in the teaching and learning of mathematics, as it could impact how mathematics is taught and enriches students' learning (Cheung & Slavin, 2013).

Blogs are one type of educational technology that has the potential to promote written communication, foster interaction, and stimulate collaborative learning to increase relational learning (Ciobanu, 2013; Deng & Yuen, 2011; Glogoff, 2005). Blogging is defined as online journals or diaries that are logs (weblogs) of thoughts, reflections, and events in the writer's life (MacBride & Luehmann, 2008).

Writing in mathematics has been studied as a tool to decrease math anxiety and increase mathematical learning and communication (Albert, 2000; Baxter et al., 2005; Borasi & Rose, 1989; Burns, 1995; Koirala, 2002; Kostos & Shin, 2010; Quinn & Wilson, 1997). Psychologists and educators have suggested powerful connections between writing and learning (Borasi & Ross, 1989). Writing has been shown to help students to think more deeply and clearly about mathematical ideas and their own learning, thereby increasing overall success in the mathematics classroom (Albert, 2000; Borasi & Rose, 1989; Burns, 1995; Koirala, 2002; Kostos & Shin, 2010; Quinn & Wilson, 1997).

Blogging allows students to participate and share their thinking at any time, from anywhere and at their own learning pace, thereby increasing overall student interactions (Alterman & Larusson, 2013; Brescia & Miller, 2006; Ciobanu, 2013; Downes, 2004). Blogging allows both peer-to-peer and peer-to-teacher interactions, thus increasing mathematical communication (Davi, Frydenberg & Gulati, 2007; Yang & Chang, 2012).

Blogging also promotes collaboration and the exchange of ideas (Davi, et al., 2007; Yang & Chang, 2012). Promoting discussions and argumentation of mathematical ideas improves learning and communication (McCrone, 2005; Webb, 2009). Blogging has been identified as one educational tool that can support student learning (MacBride & Luehmann, 2008). Research on blogging in the mathematics classroom is emerging, as educators look to increase mathematical success through the use of collaboration and technology (Alterman & Larusson, 2013; Brescia & Miller, 2006; Davi, et al., 2007; Deng & Yuen, 2011; Ellison & Wu, 2008; MacBride & Luehann, 2008; Nair, Tay, & Koh, 2013; Nehme, 2011; Williams & Jacobs, 2004; Yang & Chang, 2012). Blogging in the mathematics classroom promotes sharing, reflection, thinking and learning (Daviet al., 2007; Downes, 2004).

Mathematics achievement is a top priority worldwide (Mutodi & Ngirande, 2014), therefore it is essential that we continue to investigate new avenues to increase mathematical success in the classroom. Blogging is a new avenue that has the potential to increase mathematical communication and build relational learning through writing and collaboration while also increasing mathematical confidence, collaboration and basic mathematical knowledge.

1.2 Gaps and/or Problem Areas

The majority of research on blogging in the mathematics classroom has occurred in post-secondary educational settings (Alterman & Larusson, 2013; Davi et al., 2007; Deng & Yuen, 2011; Ellison & Wu, 2008; Johnson & Green, 2007; Nehme, 2011; Williams & Jacobs, 2004) with only one study in a secondary school environment (McBride & Luehmann, 2008). Although higher education studies have identified benefits and challenges of blogging with respect to student learning, the results cannot be readily generalized to secondary school students as their learning environment and needs are very different from students in post-secondary settings. In addition, no research could be found examining the differential impact of blogging on different ability groups.

1.3 Research Goal

The current study investigates the use of blogging in grade nine applied and academic classrooms to support communication of mathematical thinking. Specifically, the goal of the research was to identify student attitudes toward blogging, and the potential of blogging to improve mathematical confidence and learning performance were assessed.

2. Literature Review

2.1 Overview

Key areas covered in this literature review include attitudes, confidence, culture of teaching, writing, collaboration, blogging, and ability groupings in the domain of mathematics. Learning performance is discussed in each of the above areas of the literature review. Finally, the methodological limitations or previous research in blogging in mathematics will be discussed. The information contained in this literature review ranges from 1982 to 2014. Although this review spans a large time period, limited research on secondary school students and blogging exists.

2.2 Attitudes toward Mathematics

Students hold diverse attitudes about mathematics that can impede learning. First, students perceive learning mathematics as challenging, and therefore it is feared by many (Burns, 1998; Furner & Gonzalea-DeHass, 2011; OECD, 2014). According to the 2005 Gallup Youth Survey conducted in the United States, students believed that mathematics was the most difficult subject to learn (Furner & Gonzalez-DeHass, 2011). In addition, the Programme for International Student Assessment (PISA) reported that 30% of students felt helpless when doing mathematics (OECD, 2014). Two-thirds of Americans fear math, and this fear is often transferred to their children (Burns, 1998 cited in Furner & Gonzalez-DeHass, 2011).

Second, students sometimes have a fixed mindset, meaning they believe that their ability to learn mathematics is limited (Ciobanu, 2013; Dweck, 2008). Dweck and colleagues observed 373 students through grade 7 and 8 (Dweck, 2008). Students with a growth mindset had higher mathematics grades, compared to those students with a fixed mindset after two years because those students with a growth mindset cared more about the learning process (Dweck, 2008). Ciobanu's (2013) qualitative blogging research in her own secondary school classroom lead her to conclude that having a growth mindset leads to increased success. She notes how most students enter the mathematics classroom with a fixed mindset (Ciobanu, 2013).

Finally, many students have math anxiety, which can be defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and solving of mathematical problems in a wide variety of ordinary life and academic situations" (Furner & Gonzalez-DeHass, 2011, p. 228). Anxiety can lead to negative attitudes toward mathematics and result in less success on mathematics tasks (Devine, Fawcett, Szucs, & Dowker, 2012; Mutodi & Ngirande, 2014; Park, Ramirez, & Beilock, 2014). Devine et al. (2012) confirmed negative correlations between math anxiety and mathematics performance by showing that grade 7, 8 and 10 students with high math anxiety had significantly lower mathematics scores on mathematics tests. A survey of 120 high school students indicated that math anxiety negatively affects achievement (Mutodi & Ngirande, 2014). Park et al.'s (2014) study of 80 university students demonstrated that students who were suffering from high anxiety were less successful on a mathematics exam, compared to students who had their anxiety lowered through writing prior to the exam. Mutodi and Ngirande (2014) concluded through their study on high school students that math anxiety is a learned behaviour that can be unlearned by understanding the factors that trigger the anxiety.

2.3 Confidence in Mathematics

Self-confidence can play a critical role in learning mathematics (Stuart, 2000). A survey completed by fifth graders indicated that the majority of students had low self-confidence, disliked and felt they performed worse than their classmates (Stuart, 2000). Stuart (2000) concluded that students will only learn mathematics if they are confident in their ability to learn. The Programme for International Student Assessment (PISA) reported that 30% of grade 9 students indicated they feel helpless when doing mathematics (OECD, 2014). The Trends in International Mathematics and Science Study (TIMSS), which assesses grade 4 and 8 students in over 40 countries, reported that only 34% of fourth graders and 14% of eighth graders expressed confidence in their mathematical abilities (Mullis et al., 2012). This finding indicates that students' mathematical confidence may decrease as students' progress through their educational careers. Only 6.7% of high school students in the Mutodi and Ngirande (2014) study indicated they were confident speaking up in mathematics class. Mathematics is a cumulative discipline -therefore it is critical to build self-confidence early in the learning process (Mutodi & Ngirande, 2014).

Student confidence in mathematics may be increased through certain classroom activities (Kalchaman, 2011; Ku et al., 2014; Veggel & Amory, 2014). The results of the Ku et al. (2014) study indicated that grade 4 students of all ability levels were able to increase their confidence through game-based learnings. Kalchman (2011) observed 70% of the grade 5 students in one classroom increased their mathematical confidence through a weekly 'Math in Everyday Life' assignment, as students could build their mathematics skills through relevant and meaningful activities. First-year university students who attended voluntary mathematics tutorials were able to increase their confidence from an average of 3 to 7 out of 10, due to the small group learning setting created by the tutorial (van Veggel & Amory, 2014). It appears then that students need an appropriate learning environment to build mathematical confidence.

2.4 Culture of Teaching Mathematics

Teaching is a culturally transmitted practice and a number of instructors will teach the same way they were taught (Furner & Gonzalez-DeHass, 2011; Skemp, 2006; Stigler & Hiebert, 2004). Teachers demonstrate at least two different fundamental approaches to learning mathematics. One is from an *instrumental* perspective, which involves solving questions using facts and procedures, and the other is from a *relational* perspective, which involves solving questions by selecting different strategies and skills (Skemp, 2006). Unfortunately, some teachers were not taught mathematics in a meaningful way (Koirala, 2002). Journal entries by pre-service teachers stated that they themselves had a hard time explaining their thinking to mathematics questions as they were taught to accept rules and procedures without understanding why they work (Koirala, 2002). It is challenging for teachers to change from an instrumental to a relational teaching approach (Koirala, 2002). Only 53% of students reported that their teacher presented them with questions that required them to think (OECD, 2014). The instrumental approach to teaching mathematics can create a situation where students produce correct answers without knowing why the answer is correct (Burns, 1995; Cooper, 2012; Kostos & Shin, 2010; Richhart et al., 2011). Learning mathematics for understanding is fundamentally different from memorizing mathematical procedures. Therefore it is essential that we continue to investigate new avenues to increase relational learning in the mathematics classroom.

2.5 Writing in Mathematics

2.5.1 Benefits

The National Council of Teachers of Mathematics (NCTM) recommends that written communication should be encouraged in mathematics, as it increases understanding (Cooper, 2012). Learning through writing can be described as a "meaning-making process," whereby the learner is actively building connections between what they are learning and what they already know (Alterman & Larusson, 2013; Borasi & Rose, 1989; Cooper, 2012). Restating facts, concepts and rules in one's own words can facilitate internalization, as students have an inner conversation with themselves to make their understandings concrete and their own (Albert, 2000; Borasi & Rose, 1989; Burns, 2004). According to Koirala (2002), construction of knowledge is a continuous process, therefore it must be regularly communicated and reflected. Communication through writing is a key part of developing mathematics understanding (Carley, 2011).

A number of studies have reported that journaling can be used to communicate and learn mathematics (Albert, 2000; Borasi & Rose, 1989; Koirala, 2002; Kostos & Shin, 2010; Morris, 2006). A review of the literature identified at least five main benefits to students who participate in journal writing in mathematics class. First, journaling can increase students' mathematical understanding. In a mixed methodology study by Kostos and Shin (2010), 13 out of 16 primary students increased their understanding of mathematical vocabulary through teacher-prompted journaling. A case study conducted by Albert (2000) reported that grade 7 students increased their mathematical understanding through writing. Quinn and Wilson (1997) surveyed teachers at the second, fifth and eleventh grade levels. The majority of teachers indicted that they felt writing was extremely beneficial to students mathematical understanding, as it allowed them to identify mistakes and solidify new knowledge (Quinn & Wilson, 1997).

Second, journaling can increase students' thinking and problem solving skills. Carter (2009) found that grade two students' thinking and problem solving skills increased when journaling became part of the regular classroom routine. Grade 7 students examined in a case study developed more clear and concise strategies to solve mathematical problems through writing (Albert, 2000). Thirteen out of 16 grade 2 students examined in a mixed methodology study increased their mathematical thinking from the pre- to post-assessment (Kostos & Shin, 2010).

Third, journaling allows students' to self-monitor their learning. Grade 7 students participating in a case study by Albert (2000), reported they felt that writing helped them keep track of their thinking and solutions when solving mathematical problems. Koirala (2002) observed that pre-service teachers increased their mathematical understanding through journal writing, as it required them to monitor their own mathematical thinking on a regular basis. Pre-service teachers expressed how they liked journaling in mathematics, because it gave them time to reflect on what they learned and ask questions before the next class (Koirala, 2002).

Fourth, journaling can increase students' mathematical communication. In a case study by Baxter et al. (2005), three out of four grade 7 students who never spoke up in class were able to explain their understanding and thinking in their mathematics journals. Morris (2006) observed post-secondary students using the writing center to improve their mathematical communication and thinking, as it allowed them to build their writing skills and then apply those skills in mathematics class.

Fifth, journaling allows students to express their feelings about mathematics. In a study by Borasi and Ross (1989), journaling had a therapeutic effect on college students, as it helped to reduce the emotional components of learning mathematics. Journaling helped build mutual trust between the student and teacher, leading to a more caring classroom atmosphere (Borasi & Ross, 1989). Park et al. (2014) examined how college students used expressive writing prior to stressful situations to increase success, as it increased working memory. Pre-service teachers developed sufficient confidence to express concerns, excitements, concepts and questions in their mathematics journals as the course progressed (Koirala, 2002). When students are given the opportunity to share how they feel, a more positive atmosphere is created, and math anxiety can be reduced (Koirala, 2002; Quinn & Wilson, 1997).

2.5.2 Challenges

Although clear benefits to students exist when writing in the mathematics classroom, relatively few teachers few are actually using this strategy (Baxter et al., 2005; Koirala, 2002; Kosta & Shin, 2010; Quinn & Wilson, 1997). There are at least three documented challenges inhibiting teachers from using mathematics journaling: lack of time, limited writing ability of students, and student resistance. Mathematics journals take a lot of time for students to write, and teachers need a lot of time to read and respond to every student's journal (Baxter et al., 2005; Koirala, 2002; Kosta & Shin, 2010; Quinn & Wilson, 1997). The Baxter et al. (2005) study, where grade 7 students were writing in journals, reported that teachers did not like that the journals added to their daily workload. Kosta and Shin (2010) reported that the use of journals by pre-service teachers put a substantial work demand on the instructor. Quinn and Wilson (1997) reported that the grade 2, 7, and 11 teachers surveyed stated that there is not enough class time for students to write in journals, as there is too much curriculum to cover.

Some students do not have the writing ability to be able to express their mathematical thinking effectively making journaling a less than ideal option (Kostos & Shin, 2010; Quinn & Wilson, 1997). Kostos and Shin (2010) expressed that grade 2 students could only communicate effectively if they used pictures and symbols in their journals. The survey of grade 2, 7 and 11 teachers by Quinn and Wilson (1997) indicated that students with inadequate writing skills deterred teachers from using journaling in their classrooms, as they felt students needed outstanding English skills to be able to use journals in mathematics class effectively.

Finally, students are not always able to see the benefits that come with journal writing, therefore they are resistant to put effort into their writing (Borasi & Ross, 1989). In a study of college mathematics students by Borasi and Ross (1989), only one-third of students mentioned that journaling was beneficial in their course evaluation.

2.6 Collaboration and Mathematics

2.6.1 Benefits

Peer collaboration can be defined as students working together to complete a task by exchanging ideas and opinions (Fawcett & Garton, 2005; Koijiri, Murase & Watanabe, 2006; Samuelsson & Frykedal, 2014). Collaboration with discussion can lead to deeper understanding and academic gains, as students need to compare their ideas to others, and restructure their understandings in the process (Carley, 2011; Gupta, 2008; Fawcett & Garton, 2005; McCrone, 2005; Teasley, 1995; Vidakovic & Marton, 2004). Carley (2011) found that kindergarten and grade 3 students increased their mathematics vocabulary through regular group discussions in the classroom, leading to increase understandings. Grade 2 students who worked collaboratively in discussion groups, obtained a significantly higher number of correct responses on a sorting activity, compared to students who worked alone (Fawcett & Garton, 2005). Grade 4 students who communicated with each other during group work were able to generate higher quality hypotheses on an open-ended task, then those who worked alone (Teasley, 1995). McCrone (2005) observed grade 5 students building a shared understanding in mathematics class through group discussions. Vidakovic and Martin (2004) noted instances where group discussions influenced individual thinking in university mathematics students, which led to increased learning, and problem-solving skills. According to a literature review by Gupta (2008), if students have a chance to explain their thoughts to someone else, they can solidify their learning.

Collaboration in mathematics classrooms has been associated with increases in confidence (McCrone, 2005; Vidakovic & Martin, 2004). McCrone (2005) observed grade 5 students taking more intellectual risks in the classroom as the year progressed because they were able to build confidence in their small collaborative groups. In whole class discussion, a number of students remained silent and did not collaborate. Deep mathematical understanding did not develop until small collaborative groups were created in the classroom thereby allowing student discussion (McCrone, 2005). Group discussions influenced individual mathematical thinking for university students, leading to increased self-confidence (Vidakovic & Martin, 2004).

2.6.2 Challenges

The success of peer collaboration depends on a number of factors including grouping arrangement and the assigned task (Fawcett & Garton, 2005; Gupta, 2008; Samuelsson & Frykedal, 2014; Teasley, 1995). Research on children's collaboration over the past two decades has shown that merely putting children together is not enough (Teasley, 1995). The benefit of collaborative work is dependent upon student participation in the group (Johnson & Green, 2007; Teasley, 1995; Webb, 2009). Meaningful participation occurs when a group has had extensive and relevant interactions about an assigned task (Vidakovic & Martin, 2004). In Vidakovic and Martin's (2004) study, university mathematics students' collaborative sessions were rated as meaningful when students had an extensive interaction that addressed the problem and lead to a solution. Tasks that arrange grade 5 students into small cooperative groups lead to more meaningful mathematics discussions than large group arrangements (McCrone, 2005).

Teachers must prepare students for effective collaboration, by training them how to work effectively in a group (Gupta, 2008; Fawcett & Garton, 2005; Webb, 2009). Fawcett and Garton (2005) stated that children need training in interactive skills, such as how to explain ideas, how to give and receive feedback and how to be sensitive to others, to be successful in collaborative work. Webb (2009) notes that teachers muct teach collaborative strategies and listening skills directly, as well as provide regular prompting in the early stages of collaboration. In a study by Golbeck and Sinagra (2000), collaboration among university students failed to show an increase in learning as the peer roles were too loosely established. Students did not understand their responsibilities within the group, and therefore limited collaboration occurred (Golbeck & Sinagra, 2000). According to

Gupta (2008) a great deal of practice is needed to develop the skills for any discipline, and collaboration is no exception.

Open-ended tasks that allow multiple ways to produce an answer are optimal for collaborative work, as the different opinions that are expressed can help lead to an answer (Webb, 2009). Difficulty level of a collaborative task can also have an impact on success. Samuelsson and Frykedal (2014) found that when a task is too easy or too difficult, grade 9 students were unable to work collaboratively and complete the task. Fawcett and Garton (2005) observed that grade 2 students did not increase their knowledge if the sorting task was too difficult for the pair. Students can acquire knowledge through collaboration and discussions, however, the knowledge they can gain is limited if they are unable to reach the answer. Therefore monitoring by the teacher is essential for success to ensure a task is at an appropriate level for students (Koijiri et al., 2006).

2.7 Blogging and Mathematics

2.7.1 Overview

In the past 10 years, there has been a steady increase in the use of web 2.0 technologies, with a focus on participation over presentation (Cooper, 2012; Deng & Yuen, 2011). Blogging, defined as online journals or diaries that are logs (weblogs) of thoughts, reflections, and events in the writer's life are particularly popular as millions of people worldwide have blogs, and millions more read them (Davi et al., 2007; Downes, 2004; Ellison & Wu, 2008; Nair et al., 2013; Nehme, 2011; Pedersen & Macafee, 2007; Williams & Jacobs, 2004). For young adults, using technology for self-expression is a deeply engaging part of their lives (Ellison & Wu, 2008). Approximately 50% of blog authors are under the age of twenty (Davi et al., 2007; Ellison & Wu, 2008; MacBride & Luehmann, 2008;

Pedersen & Macafee, 2007). Blogging can also support student learning in the classroom, as it capitalizes on interest and familiarity with online communication and extends learning beyond the classroom (Glogoff, 2005; MacBride & Luehmann, 2008; Williams & Jacobs, 2004).

2.7.2 Benefits

Blogs are a powerful platform in mathematics classrooms allowing students and teachers to engage in rich conversations that support student learning (Ciobanu, 2013; Johnson & Green, 2007). There are at least four benefits to using blogging in the classroom. First, blogging creates a community of learning outside the classroom, making the learning process student-centered and interactive (Glogoff, 2005; MacBride & Luehmann, 2008). Glogoff (2005) found that using blogging in his university courses extended the classroom into the virtual world, making the learning in his courses more student-centered as blogging utilized the social component of learning. MacBride and Luehmann (2008) found blogging encouraged grade 11 students to reflect and discuss mathematics content beyond a lesson on the blog. Students develop a better connection with their teacher and other students through blogging, which allows them to feel more comfortable on the blog and in the classroom (Cuhadar & Kuzu, 2010). University students in the Cuhadar and Kuzu's (2010) study pointed out that increasingly positive relationships were built on the blog, as students were more intimate with their other classmates through the blogging activities. In a study of 48 British bloggers, Pedersen and Macafee (2007) noted that blogging can be a good support network for people.

Second, blogging increases collaboration. Blogging allows students and teachers to collaborate outside the classroom and gives students access to curriculum content and support 24/7 (Alterman & Larusson, 2013; Cuhadar & Kuzu, 2010; MacBride & Luehmann, 2008). The 25 university students in the Alterman and Larusson (2013) study were able to use the blogging content throughout the semester as a resource for other learning activities because the blog content remained throughout the semester. University students in the Cuhadar and Kuzu (2010) study noted that they were able to reach course content on the blog for classes that they were unable to attend, therefore making the learning process more effective. Students also felt they interacted more with their teacher on the blog then they would in the regular classroom (Cuhadar & Kuzu, 2010). Grade 11 mathematics students commented that the blog helped them complete their homework at night (MacBride & Luehmann, 2008). Williams and Jacobs (2004) suggested that students learn as much from each other as they do the textbook through collaboration activities, like blogging (Yang & Chang, 2012).

Third, considerable research suggests that blogging supports student learning. Blogging requires students to write, read, reflect and question (Downes, 2004). Knowledge is shared on the blog as students post their own thoughts and read the various perspectives of others (Alterman & Larusson, 2013). University students in the Alterman and Larusson (2013) study built common knowledge through the social interactions on the blog. Over 70% of fifth grade students who completed a survey on their blogging experiences indicated that blogging was important, interesting and useful to their learning (Nair et al., 2013). A mixed-methodology study by MacBride and Luehmann (2008) reported that grade 11 students believed that their learning was being supported through peer-to-peer interactions on the blog. Davi et al. (2007) conducted a blogging study in five college classrooms. Students reported that they enjoyed blogging, because it exposed them to a variety of opinions and perceptions, thereby improving their learning (Davi et al., 2007). Over 95% of students in a university mathematics course felt reading other students' blog posts was beneficial to their learning, as it presented different perspectives (Nehme, 2011). In a qualitative blogging study by Ellison and Wu (2008), 52 university students reported that reading other students' blogs was most helpful for understanding course content. Seventy percent of education university students in a qualitative study by Deng and Yuen (2011) found that reading blog posts helped with their professional growth. Blogging can develop critical thinking skills as students must carefully reflect and evaluate their own work and the work of others (Davi et al., 2007; Downes, 2004; Hehme, 2011; Williams & Jacobs, 2004). Metacognition naturally develops as students compare their understandings with others in the online environment (Cooper, 2012).

Finally, blogging can create a safe space for learning. Blogs can help students who are uncomfortable speaking up in the classroom, as they can become active participants in the online world (Johnson & Green, 2007). Johnson and Green (2007) observed that when university students used online discussion forums, students who were unwilling to speak up in the classroom were able to find a voice online. Davi et al. (2007) noted that the blogging required college students who were not likely to participate in class to post some of their thoughts and reflections on the blog, which allowed them to contribute to the discussion. They also saw an increase in the length of the blog posts over the semester (Davi et al., 2007). Cuhadar and Kuzu (2010) also observed university students writing more on the blog as the 10-week study progressed. Blogging has the potential to benefit to all students, even the inactive online learner who just reads the blog posts (Davi et al., 2007; Deng & Yuen, 2011). Over 70% of college students in the Davi et al. (2007) study stated that just reading blog posts assisted in their learning. Similarity in the Deng and Yuen (2011) study, around 70% of university participants felt the reading the blogs of their peers contributed to their professional learning. Blogging is unique because it gives students the opportunity to think and reflect before responding to a question, reducing the pressures that students can feel within the classroom (Brescia & Miller, 2006; Johnson & Green, 2007; Yang & Chang, 2012). University students using online discussion forums were able to organize their ideas before responding, increasing the depth of their responses (Johnson & Green, 2007). Nearly 70% of student teachers in the Deng and Yang (2012) study acknowledged that blogging allowed them to self-reflect. Professors who participated in the Brescia and Miller (2006) survey noted that the major benefit to blogging is that participates have time to synthesize information before responding, which increases engagement and reduces anxiety. Students can feel secure during their learning journey, knowing they do not have to meet a certain deadline on the blog. Although many benefits to using blogging in the mathematics classroom have been identified, research is still rather limited at the secondary school level.

2.7.3 Challenges

Wide-spread use of blogs in educational settings is relatively limited for at least five reasons. First, teachers have a somewhat restricted understanding of how to use blogs effectively in the classroom (Yang & Chang, 2012). A review of the literature by Yang and Chang (2012) notes that educators understanding of social software and how to use discussion forums and blogs effectively are minimal at best. The benefits of classroom blogging depend largely on how the teacher structures and uses the blog (MacBride & Luehmann, 2008; Nair et al., 2013). In the grade 11 mathematics class MacBride and

Luehmann (2008) observed the need for ongoing awareness of students' strengths and needs and regular planning for blogging to be successful. Teachers commented that closer monitoring and prompting were needed for grade 5 students to make successful blog submissions (Nair et al., 2013). Mathematics activities in the 'Talking Math, Blogging Math' curriculum still needed to be scaffolded to allow students in grade 7, 8 and 9 to be successful (Mathews, 2009). Teachers who use technology in their classroom want to know how to use it more effectively, so that students' learning is better supported (Brescia & Miller, 2006).

Second, the learning that can be accomplished through blogging depends largely on student interactions, however, successfully promoting discussions in a virtual classroom can be challenging as some students just sit back and do not participate (Deng & Yuen, 2011; Glogoff, 2005). Deng and Yuen (2011) reported that over half the posts made by education students did not receive any comments. Glogoff (2005) reported that within in his own university classrooms he was unable to lure lurkers into participating in the discussion forum or blogs, even with incentives.

Third, there is the potential for students to be rude or mean on the blog (Ellison & Wu, 2008; Nair et al., 2013). University students felt that their blogging work was not good enough when they received a negative comment or no comment at all (Ellison & Wu, 2008). The six grade 5 teachers in the Nair et al. (2013) study all agreed that close monitoring and prompting was needed for blog success, as the teacher needs to ensure content is positive and helpful to students learning.

Fourth, there is always a risk of technology not work effectively, which can frustrate teachers and students (Davi et al., 2007; Ellison & Wu, 2008; Nair et al., 2013). Eight out of

18 grade 5 students interviewed in the Nair et al., (2013) study reported they were frustrated by blogging due to the technical and logical issues. Undergraduate university students in the Ellison and Wu (2008) study noted various technical concerns, such as uncertainty as to whether or not their work had been received by the teacher. Davi et al. (2007) reported that 22% of college students said they have trouble posting or responding to a post on the blog. Finally, university mathematics students commented that blogging was not enjoyable because it took too long to upload attachments (Nehme, 2011).

2.8 Academic vs. Applied Classrooms

2.8.1 Benefits

Ability grouping can be defined as the practice of organizing students into homogeneous groups based on perceived skill (Ansalone, 2010; Chmielewski, Dumon, & Trautwein, 2013; Kulik & Kulik, 1982; McCarter, 2014; Slavin, 1990; Tiesco, 2003). Ability grouping may also be called streaming or tracking (Ansalone, 2010; Chmielewski et al., 2013). Placing students into groups for learning is a common practice worldwide (Ansalone, 2010; Chmielewski et al., 2013; McCarter, 2014). In secondary schools, students are often placed in either a university or vocational track (McCarter, 2014; Slavin, 1990). However, in the last decade, schools have developed more flexible streaming, allowing students to move between levels for different subject areas (Ansalone, 2010; Dulfo, Dupas & Kremer, 2009; McCarter, 2014).

In Ontario, students in grade 9 and 10 mathematics are placed into two different streams, academic or applied. According to the Ministry of Education (2005), the academic course focuses on essential mathematical theories and abstract problems to develop students' knowledge and skills, whereas the applied course develops students' mathematical knowledge and skills through practical applications and concrete examples. The mathematical process, though, is considered to be essential in both streams (Ministry of Education, 2005). Ability grouping is implemented in areas such as mathematics to help teachers differentiate instruction (Ansalone, 2010; McCarter, 2014; Slavin, 1990). Hunt and Preston (2014) define differentiated instruction as a method of instruction where teachers modify the curriculum and their method of teaching to meet the needs of the students. When a teacher provides the correct content, at an appropriate level and pacing, students will experience success (Hunt & Preston, 2014; Tiesco, 2003; Walters, 2014). Research into ability grouping has shown that homogenous grouping can be effective in certain areas including mathematics and gifted programs (Ansalone, 2010; Kulik & Kulik, 1982; McCarter, 2014; Slavin, 1990).

2.8.2 Challenges

Although homogeneous grouping benefits some students, other students are more successful in heterogeneous classroom settings. According to a study by Hunt and Preston (2014), grouping students in grades 4 to 6 based on their mathematics level had positive impact on high-achieving students, but not on low-achieving students. On the other hand, Wang (2013) and Slavin (1990) noted that low-achieving secondary and college students needed stronger students to stimulate and encourage them. With heterogeneous classrooms, low- achieving students may have the support they need to be successful (Wang, 2013). Chmielewski et al. (2013) observed that high-track students on the PISA reported high mathematics self-concept, compared to low-track students who reported low mathematics self-concept. Self-concept can be defined as a person's perception of their abilities (Chmielewski et al., 2013). Grouping practices have different effects on student achievement based on the type of curriculum that is developed for each group (Tiesco, 2003). Slavin (1990) states that unless teaching methods are systematically changed, ability grouping has little impact on student achievement. To date no research has been conducted on ability group's use of blogging in the mathematics classroom.

2.9 Limitations and Methodological Issues

There are at least six limitations in previous research focusing on blogging in educational settings. First, based on a review of the literature, 75% of educational blogging studies are conducted in post-secondary institutes (Alterman & Larusson, 2013; Brescia & Miller, 2006; Cuhadar & Kuzu, 2010; Davi et al., 2008; Deng & Yuen, 2011; Ellison & Wu, 2008; Glogoff, 2005; Nehme, 2011; Williams & Jacobs, 2004; Yang & Chang, 2012). Second, educational studies which have examined blogging focused on language or business, not mathematics (Alterman & Larusson, 2008; Brescia & Miller, 2006; Cuhadar & Kuzu, 2010; Davi et al., 2008; Deng & Yuen, 2011; Ellison & Wu, 2008; Glogoff, 2005; Nair et al., 2013; Williams & Jacobs, 2004; Yang & Chang, 2012). Third, a number of studies on blogging contained anecdotal data from personal observations but no empirical data (Brescia & Miller, 2006; Ciobanu, 2013; Glogoff, 2005; Nehme, 2011). Fourth, although both qualitative and quantitative data were collected in a number of studies through interviews and surveys, some studies neglected to analyze the actual content of the blog (Ciobanu, 2013; Davi et al., 2007; Ellison & Wu, 2008; Williams & Jacobs, 2004). Fifth, educational blogging studies have focused exclusively on single ability groups (Alterman & Larusson, 2013; Brescia & Miller, 2006; Ciobanu, 2013; Cuhadar & Kuzu, 2010; Davi et al., 2008; Deng & Yuen, 2011; Ellison & Wu, 2008; Glogoff, 2005; MacBride & Luehann, 2008; Nair et al., 2013; Nehme, 2011; Williams & Jacobs, 2004; Yang & Chang, 2012). Finally, no studies have examined the impact blogging could have on a student's confidence within the subject area

In addition, only one study, looked at blogging in secondary school mathematics classrooms (MacBride & Luehann, 2008). Students' blogged throughout the year, but only the blog content from the analytical geometry unit was analyzed in the study. The analytical geometry unit lasted 27 days. During the 27 days the students made 30 posts and 26 comments, and the teacher made 11 posts and 3 comments. The blog had a number of features including reflective posts, resources, and problem-solving activities. The blog site was used regularly, even when the teacher was absent from school. The blog posts were analyzed and the teacher was interviewed to collect data. The results indicated that classroom blogs capitalized on students' cultural literacies, and were a useful learning tool, however, success depended on how the teacher structured the blog. Although the MacBride and Luehann (2008) study is most similar to the current research study, some limitations are present. This study only looked at one class of the same ability, during one unit. They did not investigate student attitudes toward blogging, or whether blogging influenced student confidence. These items are addressed in the current research study.

2.10 Research Questions

Five research questions guide this study:

1. What are grade nine students' attitudes toward using blogging in mathematics class?
2. What is the impact of blogging on grade nine students' confidence in mathematics?
3. What is the impact of blogging on grade nine students' communication of mathematical thinking?

4. What is the impact of blogging on grade nine students' mathematics knowledge?
5. What is the impact of ability level (applied vs. academic) on the use of blogging in the mathematics classroom?

3. Method

3.1 Design Philosophy

This study followed a pragmatic approach to methodology. According to Creswell (2014), the pragmatism view is concerned with "application- what works- and solutions to problems" (p.10). Researchers emphasize the research problem and use all approaches available to understand the problem and try to find a solution (Creswell, 2014). Pragmatics research is problem-centered and is related to real-world practice (Creswell, 2014). Pragmatic research is also pluralistic and accepts diverse views in their research findings (Creswell, 2014). Pragmatic researchers use both quantitative and qualitative data to provide best overall understanding of a problem (Creswell, 2014).

This study aligns with the pragmatic approach because it sets out to investigate a problem, namely limitations in mathematical knowledge and communication among secondary school students, and aims to investigate and find a solution through blogging in the mathematics classroom. Pre- and post- data is collected in this study to examine the impact that blogging has on mathematical performance and mathematical confidence. The study is augmented with qualitative data on both the mathematical confidence and attitudes toward blogging survey, to provide additional information on the thoughts, feelings and opinions of the participants. This study used a convergent parallel mixed-methods approach, as both qualitative and quantitative data were collected to produce a more comprehensive analysis (Creswell, 2014). This study is also a comparative case study, as it is investigating two different groups, applied and academic classrooms, using a variety of collection tools (Creswell, 2014).

3.2 Overview

This study addressed a number of limitations reported by previous studies:

1. This research was conducted in a secondary school setting;
2. This research focused on blogging in mathematics;
3. Multiple sources of data were collected including Likert scale surveys, open-ended responses, knowledge tests, and blog analysis;
4. Blogging was compared among two different ability groups;
5. The impact of blogging on mathematical confidence was assessed.

3.3 Participants

3.3.1 Teacher

The teacher in this study had taught for five years in total, and grade nine mathematics for two years. She noted that she was comfortable teaching mathematics but was always looking for new ways to teach. She was comfortable with using technology in her classroom, but she had little experience with blogging.

The teacher had her own laptop, an LCD projector, a Smartboard, and internet access at her disposal. Laptop carts and computer rooms were available for booking, but accessibility was an issue and she was not always able to give her students access to technology when needed. Overall, she believed that the technological support at her school was good.

3.3.2 Students

Forty-eight grade nine students (31 males, 12 females, 5 no response), 13 to 16 years old, selected from two classes in a large urban secondary school, participated in this study. The school had a population of about 1640 students, with approximately 400 enrolled in grade 9. Five percent of the school population had English as a second language (ESL) and 17.4% were identified as special needs (Cowley & Easton, 2014). The average income for families at this school was $80,300 (Cowley & Easton, 2014). For this study, 27 students were enrolled in an academic stream, while 21 students pursued an applied stream.

Ninety-two percent of students enrolled in the academic class and 86% of students enrolled in the applied class reported that they often or always had internet access at home. A majority of students in both the academic (89%, *n*=27) and applied (71%, *n*=20) classrooms were comfortable or very comfortable with using school-based technology. Seventy percent (*n*=27) of students enrolled in the academic stream and 38% (*n*=20) students enrolled in the applied stream said they were comfortable or very comfortable with blogging.

3.3.3 Context of Teaching

According to the teacher, both the academic and applied classrooms experienced direct teaching and group work throughout the units. However, the students in the academic classroom were exposed to direct teaching for longer periods of time then the students in the applied classroom. The teacher kept direct instruction to less than 20 minutes in the applied classroom, as she perceived that her students were unable to sit and listen for long periods of time. Students in the applied classroom were also given handouts, so that they could focus on the lesson and not have to write content from the board. Students in the academic classroom wrote notes from the board during direct instruction. There was more group work in the applied classroom, as the teacher always moved students in the applied classroom into guided groups after direct instruction. The teacher noted that students in the academic classroom tended to prefer independent work within the classroom.

All students used manipulatives, however students in the applied classroom used them daily as they had certain tools, such as number lines, multiplication tables, and cubes, regularly on their desks. Students in the academic classroom used textbooks in the classroom, but no textbooks were used in the applied classroom. The pace within the academic classroom was much faster than in the applied classroom. Students in the applied classroom were regularly seeking assistance during class time, but this was less common in the academic classroom. The applied classroom required some behaviour management and had the support of one educational assistant.

3.4 Data Collection

3.4.1 Overview

My research included four types of data: quantitative survey data in the form of Likert questions, qualitative open-ended questions, performance tests, and blog analysis. The Likert questions provided a quantitative overview of student's confidence in mathematics and student's attitudes toward blogging in mathematics. The open-ended questions allowed student's to provide additional information in their own words about what they liked and disliked about learning mathematics and blogging in the mathematics classroom. The performance tests provided a quantitative assessment of student's knowledge before and after the use of blogging for specific mathematical units. The final component to of data collection was a quantitative assessment of student blog entries written by students. Table 1 gives a summary of the data collection tools used to answer each of the five research questions.

Table 1 – Overview of Data Collection Tools

Research Question	Data Collected	Appendix
1. What are grade 9 students' attitudes toward using blogging in mathematics class?	▪ Attitudes toward Blogging Survey	Appendix G
2. What is the impact of blogging on grade 9 students' confidence in mathematics?	▪ Pre and Post Confidence in Mathematics Survey.	Appendix F
3. What is the impact of blogging on grade 9 students' communication of mathematical thinking?	▪ Blog Activities for both classes.	Appendix J (Academic) Appendix K (Applied)
4. What is the impact of blogging on grade 9 students' mathematics knowledge?	▪ Pre and Post Knowledge Tests for each class.	Appendix H (Academic) Appendix I (Applied)
5. What is the impact of ability level (applied vs. academic) on the use of blogging in the mathematics classroom?	▪ All of the data tools were used to compare students in the academic and applied classrooms.	Appendix F, G, H, I, J, K

3.4.2 Surveys

3.4.2.1 Mathematics Confidence

A Likert-scale consisting of six, 5-point items was used to measured student confidence in mathematics before and after the blogging activities (Appendix F). The Cronbach internal reliability coefficient was 0.79 (pre-survey), and 0.81 (post-survey). These values are considered acceptable for measures used in social sciences (Kilne, 1999; Nunnally, 1978). In addition, three open-ended questions focusing on student's likes and dislikes about mathematics and student's overall confidence in mathematics were used to assess confidence in mathematics (Appendix F). Survey items from the EQAO tests (EQAO, 2013) were used to help develop this confidence survey.

3.4.2.2 Attitudes toward Blogging

A Likert-scale consisting of six, 5-point items was used to measure student attitudes toward using blogging in mathematics class at the end of blogging study (Appendix G). Referring to the surveys of Davi et al., 2007, Williams and Jacobs, 2004, and Yang and Chang, 2012 lead to the development of this survey. The Cronbach internal reliability coefficient was 0.86. This value is acceptable for measures used in social sciences (Kilne, 1999; Nunnally, 1978). In addition, two open-ended questions focusing on student's likes and dislikes about using the blogging site in mathematics class were used to assess attitudes toward blogging (Appendix G).

3.4.3 Mathematics Knowledge Pre and Post Tests

Participants completed identical pre- and post-tests for each of the three units where blogging was used. These tests assessed participants' knowledge at the start and end of the units where blogging was taking place. The pre-and-post tests for each unit were developed by the classroom teacher, and were identical. Different tests were used for students in the academic and applied classrooms. See table 2 for a detailed list of the topics covered on the tests for applied and academic sections.

Table 2– Tests Used to Measure Mathematical Knowledge

	Applied	Academic
Unit 1	Rates and Ratios (3 questions) (Appendix I)	Slope (3 questions) (Appendix H)
Unit 2	Patterning (2 questions) (Appendix I)	Linear Relationships (2 questions) (Appendix H)
Unit 3	Linear Relationships (2 questions) (Appendix I)	Measurement- Optimization (2 questions) (Appendix H)

3.4.4 Blog Entries

Students worked in randomly assigned groups of four or five students to answer mathematical questions on the blogging site, Kidblog. The teacher and researcher developed the blog questions, with different questions for the academic (Appendix J) and applied (Appendix K) classes. The academic questions were taken from the schools grade 9 problem solving question bank, and the applied questions were taken from EQAO practice booklets (www.eqao.com) or 101questions (www.101qs.com).

An attempt was made to ensure students would need to access their relational learning skills to answer each question. All units contained one closed and one open-ended question. The blog entries were examined and rated using a mathematical communication rubric (Appendix L). The Ontario Curriculum Grades 9 and 10 Mathematics was used to develop this rubric (Ministry of Education, 2005). Each student entry was examined, and a total score for all entries for each question was given a rating of 0 to 4 based on the criteria and exemplars listed in Appendix L. A student scored level 0 if no answer was given, or the answer was not related to mathematics, for example, “I don’t know.” Level 1 was given if the student demonstrated an understanding of the question through his or her answer, or an answer was given with no explanation or strategy. Level 2 was given if the student selected a strategy and tried to use it to answer the question, without any understanding as to why the strategy might work. Level 3 was given if the student selected a strategy and tried to use it to answer the question, and could explain why they chose the selected strategy. Level 4 was given if a student was able to use a strategy correctly to obtain the correct answer, and justify their answer and strategy with mathematical vocabulary and conventions.

3.5 Procedure

3.5.1 Overview

Table 3 provides the details and approximate timing for each step in this study. Participating students refers to students who consented to participate in the study. Each step will be discussed in turn.

Table 3 – Overview of the Procedure

Step	Procedure	Time
1	The teacher and students completed consent forms.	Prior to study.
2	The teacher and the participating students completed the demographic survey.	Day 1
3	Students were introduced to the blog and given time to explore the bog features.	Day 1
4	Participating students completed the Pre-Confidence in Mathematics Survey.	Day 1
5	All students completed the Unit 1 Pre-Knowledge Test.	Week 1
6	All students completed Unit 1 Blogging Activity.	Week 1 & 2
7	All students completed Unit 1 Post-Knowledge Test.	Week 2
8	All students participated in a class discussion about effective and ineffective blog posts.	Week 3
9	All students completed the Unit 2 Pre-Knowledge Test.	Week 4
10	All students completed the Unit 2 Blogging Activity.	Week 4 & 5
11	All students completed the Unit 2 Post-Knowledge Test.	Week 5
12	All students completed the Unit 3 Pre-Knowledge Test.	Week 6
13	All students completed the Unit 3 Blogging Activity.	Week 6 & 7
14	All students completed the Unit 3 Post-Knowledge Test.	Week 7
15	Participating students completed the Post-Confidence in Mathematics Survey.	Week 8
16	Participating students completed the Attitudes Toward Blogging Survey.	Week 8

3.5.2 Consent Forms

After agreeing to voluntarily participate in the study, the lead teacher in this study completed a consent form (Appendix B) and the teacher demographic survey (Appendix E). The consent form gave a general overview of the study, and gave a brief summary of what the teacher's role would be in the study. The demographic survey looked at teaching experience in grade nine, mathematics, technology and blogging. The teacher was given all the materials including permission forms, login details, and student surveys needed to implement the study in their classroom. The teacher was also given a one hour lesson on how to use the blogging site Kidblog, which covered the following topics: starting a blog, managing groups, responding to blog posts, and blog etiquette.

Next participant/parent consent forms (Appendix A) were sent home with all of the students in the participating teachers classrooms. The consent form described the general overview of the research to be conducted and stated there would be no penalty if they choose not to participate, or withdrew from the study. Since the blogging and survey activities were part of the coursework, students were expected to participate, regardless of consent. Data was only collected, though, for students with completed consent forms. One hundred percent of the students in both the academic and applied classrooms returned their consent forms, however, inconsistent attendance resulted in incomplete data for some participants.

3.5.3 Pre-Study Surveys

On the first day, students completed the participant demographics (Appendix D) and mathematical confidence surveys (Appendix F). Both surveys were administered in a pencil-and-paper format and took a total of about 10 minutes to complete.

3.5.4 Knowledge Tests

All students completed a pre-test at the start of each unit being taught during the study, and then completed the same test at the end of the unit. The three units used in the study were worked out with the teacher prior to the study beginning. The units studied and the tests used were different for the academic (Appendix H) and applied (Appendix I) classes and were developed and administered by the classroom teacher as part of the regular classroom routine.

3.5.5 Blogging Groups

The researcher randomly created blogging groups of four to five students for both academic and applied mathematics classes. At the beginning of the study, before the first unit, the teacher introduced students to the blogging site, Kidblog©. A short video was provided to explain how to use the site. Students were then given about 20 minutes to explore the blog, and post about their experiences in secondary school. The practice blog prompt read: "What has been your favourite moment in grade 9 so far?"

3.5.6 Units of Study

For each unit, students were given time in class to view the blog questions (Appendix J, K) and then post an initial response. The amount of time students received in class varied between 10-30 minutes, depending on access to laptops and technology. Each unit had two blog questions, one open-ended and one closed question. In total six blogging questions were analyzed for the study over three units. Students were then expected to log on to the blogging site at least one more time during the week to engage in conversations with their peers to try and solve the assigned questions. Students were supposed to log on to the blogging site on their own time, however, if students completed other work early in class they were able to log on to the blog site in the classroom.

The teacher monitored the conversations on the blog and prompted students when needed using the teacher prompts (Appendix J, K). The teacher only used prompts when she felt the students in a group were having difficulty making progress toward a solution. The teacher started and closed the blogging period for each unit at the start and end of each unit. Both blogging questions were available throughout the unit. The length of each blogging period varied from 1.5 to 2.5 weeks depending on the unit. After completion of the first unit, the teacher had an approximately 40 minute class discussion about the blog posts. Using some examples from the blog, the class discussed effective and ineffective blog posts.

3.5.7 Post-Study Surveys

When all three units were completed, participating students filled in the confidence in mathematics survey (Appendix F) and the attitudes toward blogging survey (Appendix G), which each took about 10 minutes to complete.

3.6 Research Design and Data Analysis

A summary of the data collection analysis used to address each research question is provided in table 4.

Table 4 – Overview of Data Collection Analyses

Research Question	**Data Collection Analyses**
1. What are grade 9 students' attitudes toward using blogging in mathematics class?	• Descriptive statistics and a frequency analysis were done on the blogging attitudes survey. • Content analyses on open-ended responses from attitudes toward blogging survey.
2. What is the impact of blogging on grade 9 students' confidence in mathematics?	• The pre and post scores on the confidence in mathematics survey were compared using a paired t-test. • Content-analysis on open-ended questions in mathematical confidence survey.
3. What is the impact of blogging on grade 9 students' communication of mathematical thinking?	• Blogging posts were analyzed and given a score from Level 0 to 4, using the mathematical communication rubric (Appendix L). • Average scores on the open vs. closed ended questions were compared using a paired t-test.
4. What is the impact of blogging on grade 9 students' mathematics knowledge?	• The average scores on each of the pre and post knowledge tests were compared using a paired t-test.
5. What is the impact of ability level (applied vs. academic) on the use of blogging in the mathematics classroom?	• Mathematics confidence and blogging attitudes of students in both the academic and applied classrooms were compared using the paired t-test. • A frequency analysis was used to compare the number of teacher prompts between the academic and applied classes.

4. Results

4.1 Overview

This study looked at five key research questions:

1. What are grade nine students' attitudes toward using blogging in mathematics class?
2. What is the impact of blogging on grade nine students' confidence in mathematics?
3. What is the impact of blogging on grade nine students' communication of mathematical thinking?
4. What is the impact of blogging on grade nine students' mathematics knowledge?
5. What is the impact of ability level (applied vs. academic) on the use of blogging in the mathematics classroom?

The results for each of these questions will be discussed in turn.

4.2 Attitudes Toward Using Blogging

4.2.1 Students in the Applied Classroom

4.2.1.1 Likert Questions

Table 5 displays a summary of students overall attitudes toward blogging in the applied mathematics class based on the post-survey (Appendix G). Over 50% of the students agreed or strongly agreed that they were confident sharing their ideas on the blog. Approximately 60% of students agreed or strongly agreed that they enjoyed blogging in mathematics class and that the blogging site was easy to access and navigate. Students were relatively neutral about whether they found the blogging site useful with a mean score of 3.1 on the 5-point Likert scale and 30% agreeing or strongly agreeing that blogging was a useful learning resource. Only 5% of the students agreed or strongly agreed that they used the blogging site on their own time.

Table 5 – Student Attitudes Toward Blogging Results in the Applied Classroom (*n*=15)

Items	Mean (*SD*)	Disagree/ Strongly Disagree	Neutral	Agree/ Strongly Agree
I enjoyed using the blogging site in mathematics class.	3.9 (0.7)	5%	24%	57%
The blogging site was easy to access.	3.8 (0.7)	5%	24%	62%
The blogging site was easy to navigate.	3.7 (0.9)	10%	24%	57%
I was confident sharing my ideas on the blogging site.	3.7 (0.7)	10%	29%	52%
I found the blogging site a useful learning resource.	3.1 (1.0)	33%	29%	29%
I used the blogging site regularly on my own time.	2.1 (1.0)	57%	24%	5%

4.2.1.2 Open-Ended Questions

Based on the open-ended qualitative responses, the general attitude toward blogging in the classroom was positive. Students (*n*=9 out of 15) commented that they liked collaborating with their peers and teacher. One student wrote, “I like how we could share our own ideas with you [teacher] and my group.” Another student added, “I like the blogging in mathematics because it helps me interact with my classmates more.” Several students (*n*=3) also liked how the blogging was different from other class work. One student noted that, “It was fun because I didn’t have to sit in a desk the whole class. Instead I got to use a computer which is much better.” Another student remarked, “I like how it’s a different way of learning.” One student (*n*=1) noted that the site should have been used more commenting, “The thing that I dislike was that I didn’t get enough time to blog.” Only three students reported technology difficulties, primarily with navigation (e.g. “It was not so easy to navigate.”).

4.2.2 Students in the Academic Classroom

4.2.2.1 Likert Questions

Table 6 displays overall attitudes toward blogging in the academic classroom at the end of the study based on the survey responses (Appendix G). Approximately 60% of students in the academic classroom agreed or strongly agreed that the blogging site was easy to access and easy to navigate. They also felt confident sharing their ideas on the blogging site, and enjoyed using the blogging site with approximately 60% of students indicating agree or strongly agree. One third of the students agreed or strongly agreed that the blogging site was a useful resource. Only 7% of students used the blogging site regularly on their own time.

Table 6 – Student Attitudes Toward Blogging Results in the Academic Classroom (*n*=22)

Items	Mean (*SD*)	Disagree/ Strongly Disagree	Neutral	Agree/ Strongly Agree
The blogging site was easy to access.	3.8 (0.9)	4%	33%	59%
The blogging site was easy to navigate.	3.8 (1.0)	11%	22%	63%
I was confident sharing my ideas on the blogging site.	3.7 (1.1)	11%	22%	63%
I enjoyed using the blogging site in mathematics class.	3.50 (1.3)	19%	33%	59%
I found the blogging site a useful learning resource.	3.2 (1.2)	22%	41%	33%
I used the blogging site regularly on my own time.	2.1 (1.1)	70%	19%	7%

4.2.2.2 Open-Ended Questions

The open-ended qualitative responses indicated that students in the academic classroom had a positive attitude toward blogging in mathematics class. Students (*n*=13 out of 22) commented that they enjoyed collaborating with their peers and the teacher. One student wrote, "I really enjoyed the fact that I could see through my own eyes how my fellow classmates think." Another student added, "I liked seeing other people's ideas to compare what they thought was right to my ideas."

A number of students (*n*=7) also liked how blogging was different from other class work. For example, one student wrote, "I like going on the computer instead of doing textbook work." Six students reported that blogging took too long, often due to issues with technology or the blogging site (e.g., "It's just the computer is really slow." and "My internet did not work all the time.").

Through collaboration two students felt they could receive the help they needed to solve a question. One student noted that, "If we were wrong then we could look at our peers answers, and find our mistakes." Although students enjoyed working with others on the blog, two students noted that it was difficult to show their mathematical work and thinking on the blog (e.g., "It was difficult to show my work." and "It was harder cause you had to do it in your head.").

4.3 Impact of Blogging on Mathematical Confidence

4.3.1 Students in the Applied Classroom

4.3.1.1 Likert-Questions

Table 7 displays students' confidence in the applied mathematics classroom prior to beginning the study based on the Confidence in Mathematics Survey (Appendix F). Over 60% of students agreed or strongly agreed that they always try their best in mathematics class. About half of students agreed or strongly agreed that they spoke up and asked for assistance in mathematics class. Only one third of students agreed or strongly agreed that they were confident in their mathematics skills or good at mathematics. Only 29% of students agreed or strongly agreed that they liked mathematics. Finally, about one quarter of the students agreed or strongly agreed they spoke up and share their ideas in mathematics class. Note that the sample size was quite small (*n*=12).

Table 7 – Students Confidence in Mathematics Pre-Survey Results in the Applied Classroom (*n*=12)

Items	Pre-Mean (*SD*)	Disagree/ Strongly Disagree	Neutral	Agree/ Strongly Agree
I always try my best in mathematics class.	4.4 (0.7)	5%	24%	62%
I speak up and get assistance in mathematics class.	4.1 (0.8)	10%	29%	52%
I am confident in my mathematic skills.	3.6 (0.7)	5%	52%	33%
I am good at mathematics.	3.5 (0.5)	10%	48%	38%
I like mathematics.	3.3 (1.0)	24%	43%	29%
I speak up and share my ideas in mathematics class.	3.1 (0.9)	33%	38%	24%

4.3.1.2 Open-Ended Questions

In the open-ended questions, four themes emerged: units being studied, ability to seek help, past mathematics history, and perceived subject difficulty. Ten (out of 12) students commented that their confidence in mathematics was dependent upon the unit being studied. One student wrote, “My confidence varies depending on the unit.” Another student added, “Depending on what I’m learning. In some cases I find I will feel very confident because I understand it. Meanwhile in other cases I won’t feel as confidence because I’m not as familiar.” Three students noted that they were confident in mathematics if they were able to seek help when needed (e.g., “I am confident in math because it is easy for me and I can get help by the teacher.”).

A number of students (*n*=10) felt that their confidence in mathematics was based on the mark they receive from their teacher. If they student received a good grade, they were confident about their abilities and had a more positive outlook on learning mathematics. One student wrote, “I am pretty confident that I can be successful in math because I am able to get an 87% in math. And if I continue to do my best, I think I can get higher than 90%.” Another student remarked, “Pretty confident because I’m good at math.” A third student added, “[I am] not very confident because I have never been good at stuff.” Most students (*n*=9) were not confident in mathematics because they perceived the subject as being too difficult. One student wrote, “I dislike math because it has too much numbers and it is very complicated.” Another wrote, “It stresses me out.”

4.3.1.3 Pre-Post Mathematical Confidence Scores

There was no-significant difference between pre-mathematics confidence scores (M=22.3, SD=2.9) and post mathematics confidence scores (M=22.1, SD=3.8, t=0.22, *ns*).

4.3.2 Students in the Academic Classroom

4.3.2.1 Likert Questions

Table 8 displays confidence in mathematics in the academic classroom prior to beginning the study. Over 80% of students agree or strongly agree that they always try their best in mathematic class. Approximately two thirds of students agreed or strongly agreed that they were confident in their mathematic skills or are good at mathematics. Over 60% percent of students agreed or strongly agreed that they liked mathematics. While 52% of students agreed or strongly agreed that they would speak up and get assistance in mathematics class, only 37% of students agreed or strongly agreed that they would speak up and share their ideas in mathematics class.

Table 8 – Students Confidence in Mathematics Pre-Survey Results in the Academic Classroom (*n*=27)

Items	Pre-Mean (*SD*)	Disagree/ Strongly Disagree	Neutral	Agree/ Strongly Agree
I always try my best in mathematics class.	4.1 (0.8)	4%	15%	81%
I am confident in my mathematic skills.	3.9 (0.8)	4%	30%	67%
I am good at mathematics.	3.8 (0.8)	7%	26%	67%
I like mathematics.	3.7 (0.9)	11%	26%	63%
I speak up and get assistance in mathematics class.	3.4 (1.3)	22%	26%	52%
I speak up and share my ideas in mathematics class.	3.2 (1.2)	22%	37%	37%

4.3.2.2 Open-Ended Questions

In the open-response section of the survey, five themes emerged: units being studied, relevance, ability to seek help, past mathematics history and perceived subject difficulty. Eighteen students felt that their confidence was based on their success in the mathematics classroom. If they received good grades, they were confident in their abilities. One student wrote, "Pretty confident because I have a pretty good mark and I usually understand how to do math problems." Another student wrote, "I like math because I'm pretty good at it." Some students (*n*=6) who are unsuccessful in mathematics are not confident in their abilities and dislike mathematics. One student wrote, "I was very confident in the beginning of this year but my confidence went slightly down because I was getting some bad marks."

Several students (*n*=17) seemed to be confident if the mathematics concepts were relevant, important and useful to them. A student wrote, "I'm really confident because I use it a lot of the time in real life." Another student added, "I like it because it can help me get a career in the future."

Sixteen students commented that their confidence in mathematics was dependent upon the focus of the mathematical unit being covered. One student wrote, "From a scale of 1-10, I am a 7, but sometimes this goes up or down depending on my strengths and weaknesses. Ex. Algebra is a weakness and measurement is a strength." Another student noted, "I am good in certain units, but not others."

Some students (*n*=9 out of 27) were not confident in mathematics because they found the subject too difficult. One student wrote, "Because some of the questions are difficult and sometimes when I try to solve it I get confused." Another wrote, "I dislike math because it requires a lot of thinking. There are too many rules and formula's too remember."

Some students (*n*=5) are confident in their mathematical abilities if they are able to receive help. A student responded, "I am very confident because I know I can understand math and if I don't I know I have plenty of ways to get help."

4.3.2.3 Pre-Post Mathematics Confidence Scores

A paired-t-test revealed that pre mathematics confidence scores (M=22.3, SD=4.2), were significantly higher than post mathematics confidence scores (M=21.0, SD=4.5, t=2.5, p<.05). According to Cohen (1988, 1992), the difference was somewhat meaningful (d=0.29). Therefore, students' overall confidence in mathematics decreased from the beginning to end of the study in the academic classroom.

4.4 Impact of Blogging on Mathematical Knowledge

4.4.1 Students in the Applied Classroom

Table 9 shows the students pre and post-mean test scores on each of the three mathematics units used in the applied classroom. Post-test scores increased significantly for all three units (p<.005). According to Cohen (1988, 1992), these changes were considered large and meaningful.

Table 9 – Students Mean Scores on Knowledge Tests in the Applied Classroom

Unit Topic	Pre-Mean[1] (*SD*)	Post-Mean[1] (*SD*)	N	t value	Cohen's d
Rates and Ratios	0.3 (0.6)	2.4 (1.2)	21	7.6*	2.2
Patterning	0.7 (0.8)	3.2 (0.8)	20	11.4*	3.1
Linear Relationships	0.3 (1.0)	2.3 (1.5)	18	5.7*	1.5

[1] Based on marking scale (Level 0 to Level 4) – see Appendix L.

* p < .005

4.4.2 Students in the Academic Classroom

Table 10 shows the mean scores on all the knowledge tests in the academic classroom. The scores between the pre- and post- knowledge tests for the slope and measurement-optimization units increased and were statistically significant. According to Cohen (1988, 1992) these changes were very large and meaningful. There was no significant difference between pre- and post-test score for the unit on linear relationships. It is worthwhile noting that the mean pre-test score for linear relationships unit appears to be higher than the means of the other two units.

Table 10 – Students Mean Scores on the Knowledge Tests in the Academic Classroom

Unit Topic	Pre-Mean[1] (SD)	Post-Mean[1] (SD)	N	*t* value	Cohen's *d*
Slope	0.6 (1.0)	3.0 (1.1)	25	10.1*	2.3
Linear Relationships	1.3 (1.2)	1.6 (1.4)	25	1.5	0.3
Measurement-Optimization	0.7 (1.0)	2.5 (1.3)	27	9.4*	1.6

[1] Five level marking scale (Level 0 to Level 4) – see Appendix L.
$*p < .005$

4.5 Impact of Blogging on Mathematics Communication

4.5.1 Students in the Applied Classroom

4.5.1.1 Frequency of Blogging

Table 11 shows the number of blog posts made by students in the applied classroom ranged from 0 to 8 posts. The majority of students (n=15) made 4 or more posts over eight weeks and three mathematics units. The mean number of posts for students in the applied classroom was 4.6 (*SD*= 2.4). This mean indicates that, on average, students in the applied classroom did not respond to every blogging question, as there were six in total.

Table 11 – Frequency of Student Blogging Posts in the Applied Classroom

# of Blog Posts	# of Students
0	1
1	1
2	4
3	0
4	3
5	4
6	4
7	1
8	3

Table 12 shows the number of blog posts made by students during each unit in the applied classroom, as well as the number of teacher prompts and responses to teacher prompts in each unit. In total, students in the applied classroom made 96 blog posts during the study. Forty-seven posts were made during the patterning unit, 31 posts were made during the rates and ratios unit, and 18 posts were made during the linear relationships unit. Students in the applied classroom did not seem to have a distinct preference for the type of question they responded to on the blog as the number of posts for closed and open-ended questions were equal.

A total of 52 teachers prompts were made during the study. Twenty-seven teacher prompts were made during the patterning unit, 25 teacher prompts were made during the rates and ratios unit, and no teacher prompts were made during the linear relationships unit. As the number of teacher prompts increased, the total number of posts by students also increased. It is worth noting that students in the applied classroom only responded to teacher prompts 21% of the time (11 student responses to 52 prompts).

Table 12 – Frequency of Blogging Posts by Unit and Question Type in the Applied Classroom

Unit	Total # of Student Blog Posts		# of Teacher Prompts		# of Student Responses to Teacher Prompts	
Question Type	Closed	Open	Closed	Open	Closed	Open
Rates and Ratios	13	18	8	17	1	7
Patterning	25	22	13	14	2	1
Linear Relation	10	8	0	0	0	0
Totals	48	48	21	31	3	8

3.5.1.2 Quality of Blogging Posts

Table 13 displays the quality of mathematical communication by students in the applied classroom, based on the scoring scheme in Appendix L. Students were at Level 1 or below across all three units, for both closed and open-ended questions. Recall that a Level 1 quality of mathematical communication indicated that a student understood the question, and gave an answer, with no explanation or justification. The students in the applied classroom had a higher mean mathematical communication score on the closed questions for the patterning and linear relationships units, and a lower mean score for the rates and ratios unit.

Table 13 –Means Scores of Blogging Posts by Unit and Question Type in the Applied Classroom

Unit	Closed Question Mean (*SD*)	Open-Ended Question Mean (*SD*)
Rates and Ratios	0.5 (0.8)	1.0 (1.0)
Patterning	1.5 (0.8)	1.0 (0.5)
Linear Relationships	1.1 (1.5)	0.6 (0.7)

Table 14 indicates the frequency of mathematical communication scores assigned to student blog posts in the applied classroom across each of the mathematical units. The quality of blog entry scores appeared to vary as a function of the units. For the rates and ratios unit and linear relationships unit the majority of students scored a level 0 or 1. However, in the patterning unit, the majority of students scored level 1 or 2.

An analysis of the blogging entries revealed almost no peer-to-peer interaction among students in the applied classroom.

Table 14 – Frequency of Students' Math Communication Scores by Unit in the Applied Classroom (*n*=21)

Unit	% Level 0		% Level 1		% Level 2		% Level 3		% Level 4	
	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open
Rates &Ratios	67%	38%	19%	38%	14%	14%	0%	10%	0%	0%
Patterning	14%	14%	29%	71%	52%	14%	5%	0%	0%	0%
Lin Relations	52%	57%	24%	29%	5%	14%	0%	0%	19%	0%

4.5.2 Students in the Academic Classroom

4.5.2.1 Frequency of Blogging

Table 15 shows the number of blog posts made by students in the academic classroom ranged from 0 to 10 posts. The majority of students (*n*=16) made 5 or more posts over eight weeks and three mathematics units. The mean number of posts per student was 5.1 (*SD*= 2.2). This mean indicates, that on average, students in the academic classroom did not respond to every blogging question, as there were six in total.

Table 15 – Frequency of Student Blogging Posts in the Academic Classroom

# of Blog Posts	# of Students
0	1
1	0
2	2
3	4
4	3
5	4
6	7
7	3
8	1
9	1
10	1

Table 16 shows the number of blog posts made by students in the academic classroom during each unit, as well as the number of teacher prompts and responses to teacher prompts in each unit. In total, students made 138 blog posts during the study. Fifty-three posts were made during the slope unit, 45 posts were made during the linear relationships unit, and 40 posts were made during the measurement-optimization unit. Students made slightly more blog posts on the closed question in each unit. A total of 59 teachers prompts were made during the study. Thirty teacher prompts were made during the linear relationships unit, 18 teacher prompts were made during the measurement-optimization unit, and 11 teacher prompts were made during the slope unit. Overall, students in the academic classroom responded to teacher prompts 66% of the time (39 student responses to 59 prompts). Students responded to a high number of prompts in the slope and measurement-optimization units. However, the high number of teacher prompts in the linear relationships unit resulted in almost no responses.

Table 16 – Frequency of Blogging Posts by Unit and Question Type in the Academic Classroom

Unit	Total # of Student Blog Posts		# of Teacher Prompts		# of Student Responses to Teacher Prompts	
Question Type	Closed	Open	Closed	Open	Closed	Open
Slope	27	26	9	2	7	4
Linear Relationships	25	20	16	14	3	1
Measurement-Optimization	20	20	7	11	8	7
Totals	72	66	32	27	18	21

4.5.2.2 Quality of the Blogging Posts

Table 17 indicates that the quality of students' average mathematical communication in the academic classroom was at Level 1 or below across all three units on both closed and open-ended questions. The students in the academic classroom had slighter higher scores for mathematical communication posts on the closed questions for all three units compared to open-ended questions.

Table 17 –Means Scores of Blogging Posts by Unit and Question Type in the Academic Classroom

Unit	Closed Question Mean (*SD*)	Open-Ended Question Mean (*SD*)
Slope	1.4 (1.0)	1.1 (1.1)
Linear Relationships	1.6 (1.3)	1.4 (1.3)
Measurement- Optimization	1.0 (1.0)	0.9 (0.9)

Table 18 indicates the frequency of mathematical communication scores assigned to student blog posts in the academic classroom. The majority of students scored a level 1 or 2 in the slope unit. In the linear relationships unit the majority of students scored a level 0 or a level 2, with fewer students scoring a level 1. In the measurement-optimization unit most students scored a level 0 or 1.

Table 18 – Frequency of Math Communication Scores by Unit in the Academic Classroom (*n*=27)

Unit	% Level 0		% Level 1		% Level 2		% Level 3		% Level 4	
Type of Question	Closed	Open	Closed	Open	Closed	Open	Closed	Open	Closed	Open
Slope	19%	33%	41%	37%	26%	19%	15%	7%	0%	4%
Linear Relationships	30%	37%	15%	11%	33%	30%	15%	15%	7%	7%
Measurement Optimization	33%	41%	41%	37%	15%	19%	11%	4%	0%	0%

Three of the six blogging groups in the academic classroom had strong peer-to-peer interactions. They were able to help each other progress through their work on different questions Table 19 shows sample peer-to-peer conversation from three blogging questions. Example 1 shows how students were able to help each other get started on the question.

Example 2 and 3 show how students were able to question each other's thinking and use other students work and feedback to progress their work and thinking.

Table 19 – Blogging Group Conversations in the Academic Classroom

Example 1	
Student 1	How do you get that? I don't know where to start?
Student 2	Start by extending the frustum to make a cone. The find the SA.
Student 1	How do you extend it?
Student 3	To extend the frustum you have to double the height.
Student 4	I got 3506.92 for the frustum. I got 265.76 for the cone.
Example 2	
Student 1	The slope of the ladder should be 7.9 because it's 1.6 more than 6.3 and 1.6 less than 9.5. If you add 6.3 and 9.5 together and divided by 2, should get 7.6, which is evenly spaced out between 6.3 and 9.5.
Student 2	Oh I get it, you do 6.3-9.5 and get 3.2, then you divide by two and get 1.6.
Student 1	Yes basically.
Student 2	That's wrong because we learned how to calculate slope and that's not it.
Student 3	I agree.
Student 4	I got -3.2.
Student 5	I got the same answer as Student 1.
Student 1	So how do we do this question?
Example 3	
Student 1	m=y2-y1/x2-x1 m=2350-1825/28000-17500 m=0.05 Now I know that 0.05 is the slope since I used the slope formula. y=mx+b 2350=0.05x28000+b 2350=1400+b b=950 To find the b value I will plug in the x and y values to find the value of b. y=0.05x+950 y=0.05(47000)+950 y=2350+950 y=3300 Now I plug in 4700 to find total pay. Therefore Hannah's total pay is $3300 when her sales are $470.
Student 2	Isn't the equation y=mx+b to find the slope.
Student 3	y=mxplusb y=2350=0.05x28000+b 2650=1400+b b=940
Teacher	Excellent job. Can you explain what you did in words? How did you find m and b?
Student 2	You can use the equation y2-y1/x2-x1 like Student 1 did then once you found that you can solve it in the equation for y=mx+b.
Student 4	I think we have to start off y=mx+b…I think we start off as y2-y1/x2-x1. So 1825-1700/17500-15000 =125/16000 =0.0078125 -0.007 And now I don't know where to go from here.

4.6 Impact of Ability Level and Using Blogging

4.6.1 Attitudes Toward Blogging

Table 20 indicates that students in the academic and applied classrooms had similar attitudes toward blogging in mathematics class. Over 50% of students in both the academic and applied classrooms agreed or strongly agreed that they enjoyed using the blogging site in mathematics class, that the blogging site was easy to access and navigate, and that they were confident sharing their ideas on the blogging site. The students in the applied classroom enjoyed using the blogging site slightly more than students in the academic classroom with a mean of 3.9 compared to 3.5. Only about one-third of both students in both classrooms found the blogging site a useful learning resource. Students in both classrooms were unwilling to use the blogging site on their own time, with means close to 2 (disagree).

Table 20- Comparison of Attitudes Toward Blogging between Applied (*n*=15) and Academic (*n*=22) Classrooms

	Mean (*SD*)		Agree/ Strongly Agree	
Items	Applied	Academic	Applied	Academic
I enjoyed using the blogging site in mathematics class.	3.9 (0.7)	3.5 (1.3)	57%	59%
The blogging site was easy to access.	3.8 (0.7)	3.8 (0.9)	62%	59%
The blogging site was easy to navigate.	3.7 (0.9)	3.8 (1.0)	57%	63%
I was confident sharing my ideas on the blogging site.	3.7 (0.7)	3.7 (1.1)	52%	63%
I found the blogging site a useful learning resource.	3.1 (1.0)	3.2 (1.2)	29%	33%
I used the blogging site regularly on my own time.	2.1 (1.0)	2.1 (1.1)	5%	7%

Qualitative data indicated that students in both the academic and applied classrooms enjoyed using the blogging site for its collaborative nature, and that it was different from other class work. Students in the academic classroom also felt they could receive help through the blog, making it appealing. Both groups noted that technology was sometimes an issue and prevented the blog from always being used effectively.

4.6.2 Confidence in Mathematics

Table 21 compares students' confidence in mathematics between the applied and academic classroom on the pre-survey. Students in both classrooms agree that they always try their best in mathematics, with a mean of 4 (agree). Students in the applied classroom tend to speak up in the mathematics classroom more often to seek assistance. Students in the academic classroom seemed to be slightly more confident with respect to their mathematics skills. In addition, they appeared to like mathematics more than students in applied classroom. Students in the academic classroom also seem to be more confident sharing their ideas in mathematics class with a slightly higher mean than students in the applied classroom. It is noteworthy to mention the difference in sample size between the applied (n=12) and academic classrooms (n=27).

Table 21- Comparison of Confidence in Mathematics between Applied (*n*=12) and Academic (*n*=27) Classrooms

	Mean (*SD*)		Agree/ Strongly Agree	
Items	Applied	Academic	Applied	Academic
I always try my best in mathematics class.	4.4 (0.7)	4.1 (0.8)	62%	81%
I speak up and get assistance in mathematics class.	4.1 (0.8)	3.4 (1.3)	52%	52%
I am confident in my mathematic skills.	3.6 (0.7)	3.9 (0.8)	33%	67%
I am good at mathematics.	3.5 (0.5)	3.8 (0.8)	38%	67%
I like mathematics.	3.3 (1.0)	3.7 (0.9)	29%	63%
I speak up and share my ideas in mathematics class.	3.1 (0.9)	3.4 (1.3)	24%	52%

The qualitative data indicated that student mathematical confidence in both the academic and applied classrooms was based on the unit they were studying, their ability to seek help during the unit, their mathematical past (e.g. how they did in previous years or on previous tests), and how difficult they perceived the subject of mathematics. Students in the academic classroom also felt their confidence was affected by the personal relevance of the content that was being studied, with more relevant content leading to more confidence.

Students' mathematical confidence in the academic classroom decreased significantly from the pre- to post- survey, however, there was no significant difference between per- and post- confidence survey in the applied classroom.

4.6.3 Mathematical Knowledge

Table 22 shows that the pre- to post- knowledge tests scores were significantly different for each unit being studied in both the academic and applied classrooms. The mathematics knowledge scores were significantly different for all three units in the applied classroom, and those differences were considered meaningful based on Cohen's *d* (Table 9). In the academic classroom students increased mathematics knowledge scores were significant for two of the three units, and those differences were meaningful based on Cohen's *d* (Table 10).

Table 22- Comparison of Knowledge Test Scores between Students in the Applied and Academic Classrooms

	Applied		Academic	
	Pre- Mean (*SD*)	Post- Mean (*SD*)	Pre- Mean (*SD*)	Post- Mean (*SD*)
Unit 1	0.3 (0.6)	2.4 (1.2)	0.6 (1.0)	3.0 (1.1)
Unit 2	0.7 (0.8)	3.2 (0.8)	1.3 (1.2)	1.6 (1.4)
Unit 3	0.3 (1.0)	2.3 (1.5)	0.7 (1.0)	2.5 (1.3)

4.6.4 Mathematical Communication

On average, students in the academic classroom posted 5.1 times on the blog for a total of 138 posts and students in the applied classroom posted 4.6 times on the blog for a total of 96 blog posts. Both classrooms had six blogging questions, therefore at least half of the students in both groups did not post once for every blog question. The teacher prompted both groups about the same number of times for their respective units. Students in the applied classroom were prompted 52 times and students in the academic classroom were prompted 59 times. Students in the academic classroom responded more often to teacher prompts (39 times) compared to students in the applied classroom (11 times).

Tables 20 indicated that the mathematical communication means for all blogging questions for students in both classrooms were Level 1 or below. Students in the academic classroom had a slightly higher mathematical communication mean on all three open-ended questions, and two of the three closed questions.

Table 23- Comparison of Mean Scores by Unit and Question Type between Applied and Academic Classrooms

	Applied		Academic	
	Closed Question Mean (*SD*)	Open-Ended Question Mean (*SD*)	Closed Question Mean (*SD*)	Open-Ended Question Mean (*SD*)
Unit 1	0.5 (0.8)	1.0 (1.0)	1.4 (1.0)	1.1 (1.1)
Unit 2	1.5 (0.8)	1.0 (0.5)	1.6 (1.3)	1.4 (1.3)
Unit 3	1.1 (1.5)	0.6 (0.7)	1.0 (1.0)	0.9 (0.9)

Qualitative data indicated that students in the academic classroom had more peer-to-peer interactions on the blog then students in the applied classroom and were more able to assist each other in reaching a reasonable solution to each question.

5. Discussion

5.1 Overview

The purpose of this study was to investigate the use of blogging in secondary school applied and academic level mathematics classrooms. Five questions were addressed including:

1. What are grade nine students' attitudes toward using blogging in mathematics class?
2. What is the impact of blogging on grade nine students' confidence in mathematics?
3. What is the impact of blogging on grade nine students' communication of mathematical thinking?
4. What is the impact of blogging on grade nine students' mathematics knowledge?
5. What is the impact of ability level (applied vs. academic) on the use of blogging in the mathematics classroom?

5.1.1 Attitudes Toward Blogging

Attitudes toward blogging were assessed in two ways in this study: six Likert scale items and two open-ended questions (Appendix G). A third, indirect measure of attitudes might also be actual use of the blog. For the most part, the evidence suggests that the majority of students enjoyed blogging about mathematics in the classroom.

Sixty percent of students reported that the blogging site was easy to access and navigate. This result is consistent with that fact that approximately 50% of blog authors worldwide are under the age of 20 and feel comfortable with this medium (Davi et al., 2007; Ellison & Wu, 2008; MacBride & Luehmann, 2008; Pedersen & Macafee, 2007). Even though 38% of students in the applied classroom indicated, before the study, that they were comfortable with blogging, their high familiarity with school-based technology (71% comfortable/ very comfortable) likely allowed them to still navigate and use the blog with ease. However, it should be noted that roughly one third of students were neutral or did not agree that the blogging site was easy to use, and this disparity may need to be addressed, perhaps through additional support, so that less comfortable students can make better use of the blogging tool.

Approximately six out of ten students claimed that they enjoyed blogging in mathematics class. This result is consistent with previous literature, where using technology for self-expression was identified as a deeply engaging part of young adult lives (Brescia & Miller, 2006; Ellison & Wu, 2008), so it is not surprising that students were engaged and enjoyed the blogging activities in this study. Based on some qualitative responses, a number of students liked how blogging was different from other class work. However, it is worth noting that four out of ten students were either neutral or did not like using blogs. This lack of interest is partially supported by the limited frequency in which students used the blog and the decision of most students not to use it on their own time. One possible explanation is that the topic of the blogs, mathematics questions, is not necessarily one that students would choose to participate in in everyday life. Therefore, student reluctance and negative attitudes toward mathematics, which is well documented in the literature (Ciobanu, 2013; Devine et al., 2012; Dweck, 2008; Furner & Gonzalez-

DeHass, 2011; Mutodi & Ngirande, 2014; OECD, 2014; Park et al., 2014), could have lessened enthusiasm for blogging.

Over half of the students in this study felt confident sharing their ideas on the blog. This result is consistent with the findings of Cuhadar and Kuzu (2010) who noted that university students developed stronger connections with their teacher and other students through blogging, which increased their comfort level online. Nonetheless, over a third of the students in this study were neutral or disagreed about their confidence level in blogging. Again, this finding may be reflected by the relatively minimal use of the blog. It is possible that students needed more guidance and support in using this new medium for learning mathematics, as several researches have suggested that sufficient structure is required for the effective use of blogs (MacBride & Luehmann, 2008; Mathews, 2009; Nair et al., 2013). The other possibility is that secondary students need more scaffolding and incentive to blog compared to higher educations students.

Previous research suggests that blogging can create a community of learners outside the classroom (Glogoff, 2005; MacBride & Luehmann, 2008). However, in this study, less than 10% of students used the blogging site outside of the classroom. Many students suffer from math anxiety, which could make them avoid tasks involving mathematics outside the school setting (Devine et al., 2012; Mutodi & Ngirande, 2014; Park et al., 2014). Students in this study may not have used the blogging site at home due to their anxieties around mathematics. Another possibility is that the teacher did not set up the expectations that students had to be blogging at home. In a study by Golbeck and Sinagra (2000) collaboration among university students failed as students did not understand their responsibilities. Effective collaboration will not happen without support and guidance from the teacher, so therefore more teacher training may be needed. Students may also need more time to develop appropriate blogging habits. Glogoff (2005) used incentives to increase participation on his blog and build a community of learners. MacBride and Luehmann (2008) had strict instructions of what students were required to do each day on the blog, which built a community of learners.

Only one third of the students rated the blogging site as a useful learning resource. This result does not match previous research where students built common knowledge through the social interactions on the blog and believed learning was being supported (Alterman & Larusson, 2013; MacBride & Luehmann, 2008). There are several possible explanations for these dissonant results. First, blogging interactions among peers and the instructor in this study was relatively limited, therefore students may not have seen the real learning benefits. Research by Davi et al. (2007) and Deng and Yuen (2011) noted that even inactive learners who just read blog posts can benefit from blogging. Therefore the one third of students who did find the blogging useful may have learned through just reading or observing others on the blog and not actually participating. Students are unlikely to use something on their own time that they do not see as beneficial. Borasi and Rose (1989) noted that students were not always able to see the benefits that came with journal writing in mathematics therefore they did not always put forth their best effort. Again, this result may reflect a need for more structure, support and incentives to increase activity and interaction on the blog, thereby potentially increasing usefulness. It is also conceivable that students viewed blogging as an in-class learning activity as opposed to a resource that they would consult and use later on.

The potential for blogging being a useful activity is reflected by students positive comments about collaboration. Students who used the blog commented that they liked how they could see other students' perspectives and they could build relationships with their classmates. Students in the academic classroom, in particular, also liked how they could seek assistance when needed. This finding is consistent with previous research indicating that students enjoyed blogging because they could build relationships and learn by reading and questioning other perspectives (Chudar & Kuzu, 2010; Davi et al., 2007; Nehme, 2011).

While technology was not a major issue in this study, several students reported that they did not enjoy blogging due to technological issues. This is consistent with research by Davi et al. (2007), Ellison and Wu (2008) and Nair et al. (2013) who observed teachers and students can become frustrated with blogging due to the technological challenges.

5.1.2 Confidence in Mathematics

Student confidence in mathematics was assessed in two ways in this study: six Likert scale items and three open-ended questions (Appendix F).

There was no difference between pre- and post- confidence survey scores for students in the applied classroom and students in the academic classroom saw a decrease in confidence. According to McCrone (2005) and Vidakovic and Martin (2004), collaboration can increase confidence, though such increases did not occur as a result of this study's blogging activity. One possible reason for this finding is comfort level related to sharing ideas. While about one third of students were confident speaking up and sharing their ideas in mathematics class, limited collaboration among peers and with the instructor occurred in the blogging environment. Students in this study may feel more comfortable sharing ideas in a face-to-face environment. Teachers must prepare students for effective collaboration by teaching them collaborative skills and by giving them lots of practice (Gupta, 2008; Fawcett & Garton, 2005; Webb, 2009). Also, as mentioned above, several researches have suggested that sufficient structure is required for the effective use of blogs (MacBride & Luehmann, 2008; Mathews, 2009; Nair et al., 2013). In this study students were only given one introductory blogging lesson, therefore they may not have been adequately prepared to collaborate effectively.

Many students commented that their confidence depended on the unit being studied, therefore completing the survey during a more challenging unit would result in lower confidence. Future studies may need to examine confidence in mathematics by using more refined scales that address specific content area. Some students may have low confidence in one mathematics topic and higher confidence in another, and a broad measure of mathematics confidence, typically used in the literature, may undermine the impact of context.

It is worth mentioning students in this study stated that they felt more confident if the mathematics content was relevant and useful to them. Therefore students may be able to increase mathematical confidence if the blogging activities are relevant and personally important. More attention may need to be focused on the quality, relevance and authenticity of blogging questions in order to capitalize on opportunities to increase confidence in mathematics.

5.1.3 Mathematical Knowledge

Test scores for students increased significantly from the pre- to post- test for five out of six mathematics units. Blogging involves writing and collaborating, and previous research has shown how writing and collaborating in the mathematics classroom can increase understanding and thinking (Albert, 2000; Fawcett & Garton, 2005; Kostos & McCrone, 2005 Shin, 2010). However, the fact that most students did not view blogging as a useful resource suggests that increases in knowledge were probably due to other teaching strategies used including direct teaching, classroom group work, and manipulatives. In order to establish the contribution of blogs to learning, future research would need to assess knowledge before and after blog use with no other teaching strategies used.

The content of a mathematics topic or the types of questions used may influence that relative impact of blogging, as according to student responses confidence in mathematics does change based on the unit. We may need to examine which units and questions are most effective for building collaboration and learning on a blogging platform.

5.1.4 Mathematical Communication

The majority students in this study did not respond to all blog questions, with an average number of posts per person less than six for both classes. This limited the amount of peer-to-peer interactions that could occur on the blog. Learning through blogging can only be accomplished with student interactions (Deng & Yuen, 2011; Glogoff, 2005). Cuhadar and Kuzu (2010) and Davi et al. (2007) both saw an increase in the number of blog posts as their studies progressed. Students in this study may have needed more time to build their blogging skills before they could increase the amount of posts made. Deng and Yuen (2011) reported that over the half the posts made by education students in their study did not receive any comments. This is similar to the results in this study. Students in the applied classroom only responded to teacher prompts 21% of the time, while students in the academic setting were better at responding to teacher prompts, repsonding 66% of the time. Future studies may need to examine the type of prompts that are effective at eliciting student responses.

Some students may have feared negative comments, and therefore chose not to write on the blog. Ellison and Wu (2008) commented that university students feared negative comments during their blogging study. Students may need more coaching on how to produce and accept feedback to increase interactions on the blog. Students were given a short instructional video to watch and about 20 minutes to explore the blog before beginning the study. Students also participated in a 40 minute discussion about effective blogging after the first blogging unit. This was likely not enough training to fully prepare students for the collaborative nature of the blog. Gupta (2008) notes that a great deal of practice is needed to develop collaborative skills. Another option would be to investigate if the number of posts on the blog would increase if students were anonymous on the blog. This would remove any fear of being ridiculed by peers.

According to Yang and Chang (2012), some teachers have a limited understanding of how to use blogs effectively in the classroom. MacBride and Luehmann (2008) and Nair et al. (2013) note that the benefits of classroom blogging largely depend on how the teacher structures and uses the blog. In this study, the teacher had no experience with blogging and was only given a one hour lesson on how to use the blog, which might account for students' limited performance, participation, and collaboration. Future studies may require much more instruction for the teacher to see increased interactions on the blog.

Previous research has shown that students benefit from working in small collaborative groups (McCrone, 2005; Vidakovic & Martin, 2004). However, according to

Teasley (1995) merely putting students together is not enough to see the benefits of collaborative work. In this study, students were randomly assigned to groups. No consideration was given to student personality or skill level. For example, ability pairing may have been useful. Grade 2 students, who worked in pairs where one person had a relatively higher ability, were more successful than students who worked in pairs where both students had similar abilities (Fawcett & Garton, 2005). In future studies more care may need to be taken when designing groups, to ensure meaningful discussions and learning can occur. Students may also need defined roles and guidelines to increase blog use. Golbeck and Sinagra (2000) observed failed collaboration among university students as peer roles were too loosely established. Webb (2009) notes that teachers must directly teach collaborative strategies to increase communication. No collaborative lessons occurred in this study.

The number of posts made during each unit varied by the unit for students enrolled in both academic and applied classrooms. The number of posts could be related to students' confidence and knowledge in each unit. The number of posts could also be linked to the number of teacher prompts. In the applied classroom, the lowest number of posts were made in the linear relationships unit. This could be because zero teacher prompts were made during this unit. However, students made few blog posts in relation to high number of teacher prompts made in the academic linear relationships unit. Future research may need to investigate which types of teacher prompts are effective and when teacher prompts should and should not be used to foster student thinking. According to Koirala (2002) the majority of teachers were taught mathematics themselves using an instrumental approach, therefore it is challenging to change their teaching culture to a more relational way of learning. Teachers will need more coaching on using feedback and relational learning effectively to increase success on the blog.

The quality of blog posts made by students in both classes also varied by unit. Most students scored either level 0, 1 or 2 for all units in both classroom settings. Unit difficulty and previous knowledge may have been factors in student communication scores. Students received slightly higher scores on the closed questions compared to the open-ended questions on all academic units, and two of three applied units. This is not consistent with previous research. According to Web (2009), open-ended tasks are optimal for collaborative work as they allow multiple ways for an answer to be produced. However, PISA states that only 53% of students reported that their teacher presented them with questions that required them to think (OECD, 2014). Students may not have had enough experience with open-ended thinking questions to be able to complete them successfully on the blog. Samuelsson and Frykedal (2012) found that when a task is too easy or too difficult, grade 9 students were unable to work collaboratively to complete the task. The open-ended questions on the blog may have been too challenging for students. Koijiri et al. (2006) notes that monitoring by the teacher is essential for success to ensure a task is at an appropriate level for students. Students may need more exposure to open-ended questions within the classroom before moving onto the blog. Future studies may need to investigate the most appropriate questions to use on a blog to allow student success.

5.1.5 Academic vs. Applied Classrooms

Students in both the applied and academic classrooms had similar attitudes toward blogging in mathematics class. The students in the applied classroom seemed to enjoy using the blogging site slightly more than students in the academic classroom, with a mean of 3.9 (out of 5) compared to 3.5. According to the teacher, students enrolled in the academic class preferred to listen to the lesson and then get down to work. The teacher reported that her perception was that they preferred independent work to collaborative work. Even though many students may be engaged by technology (e.g., Cooper, 2012), students in the applied classroom may have been more engaged with the blogging as they preferred collaborative work to independent work.

No difference between pre- and post- confidence survey scores for students enrolled in the applied mathematics course existed, while students enrolled in the academic course self-reported a decrease in confidence. One possible reason for this finding may be student comfort level with speaking up and getting assistance in mathematics class. Students in the applied classroom had a mean of 4.1 (out of 5) on the Likert-scale, compared to 3.4 in the academic classroom. The teacher also noted that students in the applied classroom were more willing to speak up and get assistance during class time. Therefore students in the academic classroom may have self-reported a decrease in confidence after blogging, as their confidence may have decreased when they were unable to reach an answer on the blog and needed prompting by their peers or teacher.

The decrease in confidence observed with students in the academic classroom may also be related to the units that were being studied when the confidence survey was completed. Many students commented that their confidence depended on the unit being studied, therefore completing the survey during a more challenging unit would result in lower confidence. Students completed this study near exam time, which could have impacted their responses on the confidence survey.

Test scores for students increased significantly from the pre- to post- test for five out of six mathematics units. This could be due to the nature of the unit. For example, students in the academic classroom did not see a significant increase in learning for the linear relationships unit. Upon discussions with the teacher, she felt that the linear relationships unit was one of the most challenging units for students, as students have a hard time understanding the difference between direct and partial variation. We may need to examine which units are most effective for building collaboration and learning on a blogging platform. It is noteworthy to mention that the linear relationships unit had a much higher pre-test mean than the other two units. Learning through writing occurs by the learner actively building connections between what they are learning and what they already know (Alterman & Larusson, 2013; Borasi & Rose, 1989; Cooper, 2012). Students started the linear relationships unit with more prior knowledge compared to the other two units, but they were unable to connect the new leanings to their previous knowledge and their learning did not progress.

Students in the academic classroom had stronger mathematical communication in the blogging environment. Although the units for academic and applied classrooms were different, students in the academic classroom seemed to be more able to have meaningful interactions on the blog. They had more students reaching a level 3 or 4 on mathematical communication across all units than students in the applied class. This could be because the students in the academic classroom indicated that they had more experience with blogging on the demographics survey, 70% compared to 30% in the applied classroom.

Students in the academic classroom had stronger peer-to-peer interactions than the students in the applied classroom. This could be because the students in the academic classroom had stronger mathematical abilities that allowed them to have increased discussions and collaboration. According to Hunt and Preston (2014), high-achieving students benefit from homogeneous groupings, but low-achieving students do not, as they need stronger students to stimulate them. Students can acquire knowledge through collaboration and discussions, however, the knowledge may be limited if groups members do not have enough prior knowledge to begin the task. Chwielewski et al. (2013) reported that students in low-track, such as applied classrooms, do not believe in their abilities. Students in the applied classroom may not have had enough mathematical knowledge, or believed they have enough mathematical knowledge to collaborate effectively in their groups. Teachers may need to examine different groupings within their classrooms to ensure students can stimulate each other and engage in meaningful discussions on the blog. We may need to give more attention to applied classrooms to help those students develop the skills they need to work collaboratively in a group.

There are distinct differences between using blogging in an applied and academic mathematics classroom. Students in applied classrooms are more open to collaborative work and are more willing to seek assistance, however they may need more support developing effective mathematical talk and thus will need different training and practice than students in an academic setting. Student success in academic classrooms may solely be based on the units that are being taught and the types of questions and prompts that are used. Future research needs to continue to look at blogging in different ability groups.

5.2 Educational Implications

Blogging can be used as a teaching tool in the mathematics classroom. Blogging can support student learning in the classroom, as it capitalizes on students' interest and familiarity with online communication and extends learning beyond the classroom into a virtual world (Glogoff, 2005; MacBride & Luehmann, 2008; Williams & Jacobs, 2004). However, it cannot replace other teaching strategies. Teachers will need to get creative with their implementation of blogging in the classroom, especially in situations where technology is not readily available. Academic and applied classrooms are different, and any teaching tool used, including blogging, must be adjusted to meet the classroom environment and student needs.

The collaborative nature of the blog has the potential to increase student confidence, however, confidence will not increase without effective collaboration. Therefore, building collaborative skills is essential for success on the blog. Mathematics teachers need to continue to challenge their students by bringing relational learning into the classroom and engaging students in collaborative, open-ended questions. Making time in the classroom to build collaborative skills may lead to increased learning, increased communication and increased confidence in the mathematics classroom. Blogging is one platform that can be used to facilitate collaborative discussions in the mathematics classroom.

5.3 Summary

This study had five key findings. First, the majority of students had a positive attitude toward using blogging in mathematics class, as they enjoyed that it was different from other class work and its collaborative nature. Second, blogging had little impact on students' mathematical confidence partially due to the structure of the blogs and the nature of the units. The confidence scale was not explicit enough to examine confidence by unit. Third, student knowledge did increase during the study, however it cannot be directly linked to blogging as other teaching strategies were also occurring. Fourth, mathematical communication did not increase over the course of the study due to limited student participation and low respond to teacher prompts. Student confidence, unit difficulty, previous knowledge, limited teacher and student training may all have contributed to low communication on the blog. Finally, students in the academic classroom had slightly higher mathematical communication on the blog then students in the applied classroom. This may link to students' prior experience with blogging, their increased mathematical abilities, or the unit or type of question used on the blog.

5.4 Limitations and Future Research

This study incorporated three methods of data collection, Likert-scales, open-ended questions, and blog analysis. The reliability for the scales was reasonable. However, a number of methodology limitations should be addressed and lead to future research. It was difficult to understand why students did or did not participate in the blogging activities. Although the open-ended questions provided some insight, interviews or focus group may provide more in-depth data on why students did not post, or respond to prompts. The results from this study provide only speculation about how blogging impacts mathematical communication. In addition, future studies might have students brainstorm possible questions for the blog to match interests and ideas that are relevant to them. This may increase participation on the blog.

This study did not examine what students were actually doing while they were blogging. Future studies could include screen captures and think aloud protocols that would provide insights into how students interact on the blog and how students view the blog. This would help to build understanding around why students did or did not communicate.

Students and teachers should receive coaching on effective feedback and how to respond to feedback prior to beginning future studies. Future research needs to look more closely at the type of prompts and feedback that increase student thinking and communication, and those that leave our students unable to progress. It should also examine the appropriate time to use a prompt, and when to let students preserve on their own. Lastly, it should also examine the type of questions that lead to discussions on the blog, and those that leave students not communicating. More research around using open-ended questions on blogs is needed. Future research must examine appropriate prompts and questions through both the academic and applied lens, as these students have very different classroom cultures and experiences that will affect their success.

Using the blogging platform anonymously is another avenue for future study. Students may be more willing to post and comment if they know their peers will not know it is them posting. Confidence and fear are interlinked with mathematics; therefore blogging anonymously may lead to very different results.

This research was conducted in one school with a relatively small sample size. Future research should take place in a wider variety of settings with a larger sample size. More research is needed to confirm the findings in this study and to determine whether the results are valid. The results of this study may reflect other secondary schools with a similar set-up of streaming students into academic and applied classrooms, however, therefore are many different secondary school set-ups around the world. More schools and classrooms should be involved in future studies, so that the results can be generalized.

A number of students in the sample who did not complete all sections of the research due to school absences, which may have impacted the results. Future research may need to account for students who miss classes, and provide alternative way for students' complete components of the research at another time.

Student confidence in mathematics varies based on the topic and prior experience; therefore it cannot be generalized across the subject of mathematics or across the blogging activity. The measurement of mathematical confidence needs to be altered to be more subject or content specific so that students' confidence in a specific area can be addressed with blogging questions in this area. Confidence may be a contextual specific construct. Future research could address this by measuring confidence during each blogging activity separately.

The research in this study concluded near the final examination period, which may have impacted some students' responses on the attitudes toward blogging and confidence in mathematics survey. It may also have impacted the number of students' responses on the blog, as students may have been focused on exams near the end of the study, and not on the blogging activities. Therefore student responses may not have been reliable.

The study period was relatively short, totaling only 10 weeks. Further research in this area should look at blogging in mathematics over a longer period of time, such as over an entire school semester or over multiple school years. Since time is needed to develop effective collaboration skills, we need to give more time for the study to occur. Students and teachers also need more training on how to use the blogging platform effectively. Training may be different for students in academic and applied classrooms, and thus both should be investigated.

Access to technology was sometimes an issue within the research classrooms; therefore students did not always have easy access to the blogging site. More consistent access to technology in the classroom would increase the ability for students to use the blogging site more regularly, thereby increasing collaborative skill development. Future studies should ensure technology is readily available in all participating classrooms.

The blogging platform, kidblog, did not have mathematical features or conventions within the site. This issue may have limited the consistency of blogging and the overall results. Different blogging platforms should be investigated to find a platform that is more suitable for mathematical calculations and explanations. This will make the discussions flow more effectively on the blog, and allow students to post more mathematical conventions in their answers. Also, looking for platforms that are easily accessible from various devices may increase the use by students.

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Appendix A – Parental and Student Consent Form

Dear Parent/ Guardian:

Invitation
Your child is invited to participate in a research study entitled, "Exploring the Use of Blogging on Mathematical Communication in Grade Nine Classrooms". This form outlines the purpose of the study, provides a brief description of what the study involves and describes your child's rights as a participant. It also includes a consent section.

Participating in this research study is completely voluntary. There is no impact on course success or marks if your child chooses not to participate.

Tracy Murray, a graduate student in the Faculty of Education, at the University of Ontario Institute of Technology (UOIT), is the principal investigator for this study.

Purpose of the Study
Writing in mathematics class has the potential to increase mathematical knowledge, thinking and communication. Blogging is one strategy that can be used to include writing in the mathematics classroom. The blogging site Kidblog (kidblog.org) will be used in this study. The purpose of this study is to,

1. Assess the impact of bogging on grade nine students' communication of mathematical thinking, mathematical knowledge, and confidence in mathematics.
2. Assess students' attitudes towards using blogging in mathematics class, and examine if any gender differences exist.

Methodology
During three math units your child will be asked to engage in mathematical conversations on the blog. Your child will be given time each week in class to write on the blog, but they will also be required to access the blog outside of class as part of their homework. Your child will also complete pre- and post- tests at the start and end of each unit. These activities will be part of the regular classroom curriculum and will be completed by all students. However, only those students who have consent for the research study will have their work collected and analyzed by the researcher. Students who have consent for the research study will also complete surveys at the start and end of the study, which will ask questions around confidence in mathematics, and attitudes towards blogging. All activities will be run and monitored by your child's classroom teacher. The activities are listed in the table.

Activity	Who Completes the Activity?	Time to Complete Activity?
Demographics Survey	Students with consent only.	10 minutes
Mathematics Confidence Survey	Students with consent only.	10 minutes
Pre- and Post- Tests	All students. Students with consent will have their results given to the researcher.	15 minutes/ test
Blogging	All students. Students with consent will have their results given to the researcher.	15 minutes of class time. 30 minutes outside of class.
Attitudes Toward Blogging Survey	Students with consent only.	10 minutes

Benefits of Participation
Your child will gain experience using a blogging platform, and thereby increase their technology skills. Your child will engage in meaningful mathematical conversations with their peers and teacher, which may increase overall success and confidence in mathematics. All tasks in this research study link directly to the curriculum expectations and therefore are an additional learning tool for students.

Potential Risk to the Participants
Your child may feel anxious during the research study if they struggle in mathematics, or if they are unfamiliar with technology/blogging. Your child may also worry about being judged by others. However, the risk of anxiety is no greater than what might be experienced on a regular school day.

Right to Withdraw and Confidentiality
Your child's participation in this study is voluntary. Your child's confidentiality will be preserved at all times. All raw data will be coded. Once all data has been coded the code key will be destroyed. Therefore, all data will be unidentifiable. All data collected will be kept on a password-protected laptop.

Your child is free to withdraw from the study at anytime, prior to the data being coded and anonymized, by informing the researcher. After this time, the data will be unidentifiable. If your child withdraws from the study any data that had been collected will be destroyed. If your child withdraws from the study they will still continue to participate in the study activities listed above, as they meet curriculum expectations. There will be no penalty if your child withdraws from the study.

Participant Concerns and Reporting
This study (REB #13-117) has been officially approved by the University of Ontario Institute of Technology Review Ethics Board on June 4, 2014, and by the Durham District School Board on June 23, 2014. If you have any questions regarding the research study please contact the researcher, Tracy Murray, at 289-385-2662 or tracy.murray@uoit.ca. If

you have any questions regarding your rights as a participant, complaints or adverse events, please contact the Compliance Office at 905-721-8668 ext. 3693.
The researcher will use the information from this study to write research reports, give presentations, and share insights with other teachers and researchers. When the study is complete a report on the findings will be available to interested parents in the school library.

If you agree to allow your child to participate in this study please sign the consent section and return to your child's classroom teacher by Mon, Oct 20, 2014.

Thank you,

Tracy Murray
Graduate Student, Department of Education, University of Ontario Institute of Technology

Exploring the Use of Blogging on Mathematical Communication in Grade Nine Classrooms Consent Form

I, (parent name- print) ____, have read the above information and I agree to have my child (student name- print) ____________________________________ be a participant in the study described. I understand I can ask questions at any time.

I, (student name- print) ____, have read the above information and I agree to participate in the study described. I understand that I can ask questions at any time.

By signing the research consent section below I give permission to participate in the research study, understanding that I can withdraw from the study at anytime without penalty.

By signing this form I do not waive any legal rights or recourse.

Parent Signature: ________________________________ Date: ____________

Student Signature: _______________________________ Date: ____________

Appendix B - Teacher Consent Form

Dear Teacher:

Invitation
You are invited to become a partner in the research study entitled, "Exploring the Use of Blogging on Mathematical Communication in Grade Nine Classrooms". As a research partner, you would be required to make curricular adjustments to your mathematics course.

My name is Tracy Murray, and I am a graduate student at the University of Ontario Institute of Technology (UOIT). I am the principal investigator for this study.

Purpose of the Study
Writing in mathematics class has the potential to increase mathematical knowledge, thinking and communication. Blogging is one strategy that can be used to include writing in the mathematics classroom. The blogging site Kidblog (kidblog.org) will be used in this study. The purpose of this study is to,

3. Assess the impact of bogging on grade nine students' communication of mathematical thinking, mathematical knowledge, and confidence in mathematics.
4. Assess students' attitudes towards using blogging in mathematics class, and examine if any gender differences exist.

Methodology
During three math units your students will engage in mathematical conversations on a kidblog. Your students will be given time each week in class to write on the blog, but they will also be required to access the blog as part of their homework. Your students will also complete surveys at the start, during and end of the study, which will ask questions around confidence in mathematics, and attitudes towards blogging. Student learning will be examined through your regular pre- and post- unit tests. All activities will be run and monitored by you, the classroom teacher.

Your participation involves:

- Participating in a lesson on how to use kidblog (approximately 1 hour).
- Administering and collecting consent forms from students and parents.
- Administering and collecting surveys during the study (approximately 10 minutes per survey).
- Administering and collecting pre- and post-tests as per your usual classroom routine.
- Setting up and monitoring blogging activities for your students during the three units on kigblog.org (approximately 10 minutes of prep time each week, 15 minutes of class time each week, and 20 minutes of blog reading every other night each week). Tasks include,
    - Putting the students into groups each week.
    - Starting a new blog post each week by posting the weekly blog question.
    - Monitoring blog entries, and providing support and feedback to students as needed.

Throughout the research process you will have support from me, the researcher.

Confidentiality
All raw data collected from students will be coded and completely unidentifiable. All data collected will be kept on a password-protected laptop.

Concerns and Reporting
This study (REB #13-117) has been officially approved by the University of Ontario Institute of Technology Review Ethics Board on June 4, 2014, and by the Durham District School Board on June 23, 2014. If you have any questions regarding the research study please contact the researcher, Tracy Murray, at 289-385-2662 or tracy.murray@uoit.ca. If you have any questions regarding your rights as a participant, complaints or adverse events, please contact the Compliance Office at 905-721-8668 ext. 3693.

The researcher will use the information from this study to write research reports, give presentations, and share insights with other teachers and researchers. When the study is complete a report on the findings will be available to you in your school library.

If you agree to become a partner in this study please sign the consent section below.

Attached is a Teacher Demographic Survey, which attempts to gain information about you, the teacher, and your classroom. The data collected from this survey will be confidential. This survey is voluntary. It does not have to be completed to become a partner in this research study. If you do not wish to participate in the survey you can simply not complete it and return it blank (submitting it completed will imply your consent). You can withdrawal from the survey at any time without any penalty and ask to have your data removed. By consenting to participate, you do not waive any legal rights or recourse.

Thank you,

Tracy Murray
Graduate Student, Department of Education, University of Ontario Institute of Technology

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Exploring the Use of Blogging on Mathematical Communication in Grade Nine Classrooms Consent Form

I, (teacher name- print) ____, have read the above information and I agree to become a partner in the study described. I understand that being a partner in this study will require me to make adjustments to my mathematics course. I understand that I may ask questions in the future.

By signing the consent form I give permission to become to a partner in this research study.

Signature: _______________________________________ Date: ______________

Appendix C – Thank You Letter

Dear Participant,

Thank you for participating in the University of Ontario Institute of Technology study.

This study (REB # 13-117) was officially approved by the University of Ontario Institute of Technology Review Ethics Board on June 4, 2014, and by the Durham District School Board on June 23, 2014. If you have any questions regarding the research study please contact the researcher, Tracy Murray, at 289-385-2662 or tracy.murray@uoit.ca. If you have any questions regarding your rights as a participant, complaints or adverse events, please contact the Compliance Office at 905-721-8668 ext. 3693.

You are free to withdraw from the study at anytime, prior to the data being coded and anonymized, by informing the researcher. After this time, the data will be unidentifiable. If you withdraw from the study any data that had been collected will be destroyed. There will be no penalty if you withdraw from the study.

The researcher will use the information from this study to write research reports, give presentations, and share insights with other teachers and researchers. When the study is complete a report on the findings will be available to interested parties in the school library.

Thank you

Tracy Murray
Graduate Student
Department of Education
University of Ontario Institute of Technology

Appendix D - Participant Demographics Survey

This survey is to provide background knowledge about the participant, and therefore is filled out by the participant.

Child's Name: ____

Age: ____________ **D.O.B. (mm, dd, yy):** ______________________

Gender: Female Male

1. How frequently do you have access to the internet at home?
   (Never, Rarely, Sometimes, Often, Always)

2. How comfortable are you with school-based technology (i.e. technology used at school)?
   (Not at all comfortable, Somewhat comfortable, Comfortable, Very Comfortable)

3. How comfortable are you with blogging?
   (Not at all comfortable, Somewhat comfortable, Comfortable, Very Comfortable)

Appendix E - Teacher Demographics Survey

This survey is to provide background knowledge about the teacher and their classroom.

Teacher's Name: ____

1. Years of teaching experience: _______

2. Years of experience teaching Grade 9: _______

3. Years of experience teaching mathematics: _______

4. How are comfortable are you with teaching mathematics?
   (Not at all comfortable, Somewhat comfortable, Comfortable, Very comfortable)
   Please explain your selection. ____________________________________

5. How comfortable are you with using technology?
   (Not at all comfortable, Somewhat comfortable, Comfortable, Very comfortable)

6. How comfortable are you with using technology in your classroom?
   (Not at all comfortable, Somewhat comfortable, Comfortable, Very comfortable)

7. Please rate your experience level with blogging.
   (No experience, Little experience, Some experience, Lots of experience)

8. a) Complete the table below to list the technology that is available in your classroom. Please add any items that are not listed.

Item	Yes (Y) or No (N)	Number Available
Laptop		
Desktop Computer		
LCD projector		
Smartboard		

   b) Please rate the level of technological support at your school.
   (No support, Poor, Fair, Good, Excellent)

   c) What is your overall experience with using technology at your school?

____

____

Appendix F – Participant Confidence in Mathematics Survey

Name: ____

Instruction

Please select a number indicating how much you agree or disagree with each of the following statements.

Please fill out the questions below about your confidence in mathematics.

	Strongly Disagree 1	**Disagree 2**	**Neutral 3**	**Agree 4**	**Strongly Agree 5**
a. I like mathematics.	1	2	3	4	5
b. I am good at mathematics.	1	2	3	4	5
c. I speak up and share my ideas in mathematics class.	1	2	3	4	5
d. I always try my best in mathematics class.	1	2	3	4	5
e. I speak up and get assistance in mathematics class.	1	2	3	4	5
f. I am confident in my mathematic skills.	1	2	3	4	5

g) Why do you like math?

____

h) Why do you dislike math?

____

i) Overall, how confident are you in math? Please explain.

____

Appendix G - Participant Attitudes Toward Blogging Survey

Name: ________________________________

1. Please fill out the questions below on your attitudes toward blogging in mathematics, by selecting a number to indicate how much you agree or disagree with each statement.

	Strongly Disagree 1	**Disagree 2**	**Neutral 3**	**Agree 4**	**Strongly Agree 5**
a) The blogging site was easy to access.	1	2	3	4	5
b) The blogging site was easy to navigate.	1	2	3	4	5
c) I was comfortable sharing my ideas on the blogging site.	1	2	3	4	5
d) I found the blogging site a useful learning resource.	1	2	3	4	5
e) I used the blogging site regularly on my own time.	1	2	3	4	5
f) I enjoyed using the blogging site in mathematics class.	1	2	3	4	5

g) What did you like about using the blog in mathematics class?

____

h) What did you dislike about using the blog in mathematics class?

____

Appendix H – Academic Knowledge Test

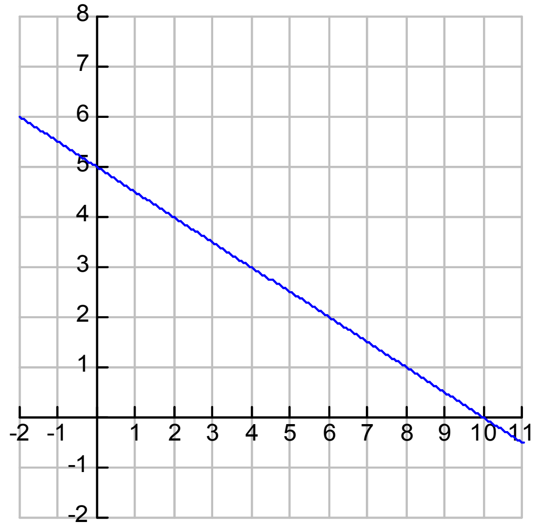
Unit 1: Slope

1. Calculate the slope between the following points without graphing. Reduce, if necessary.

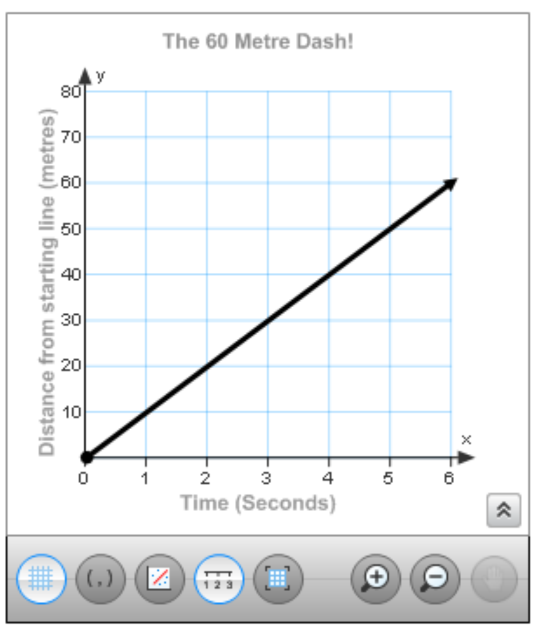
   A(-3, 4), B(7, -6)

2. Describe the following graph by filling in the table with points that satisfy the line and by creating an equation.

x	*y*



3. Below is a graph showing William's performance on the 60 metre dash.
   b) How fast is William running?
   b) How long did it take him to finish the race?



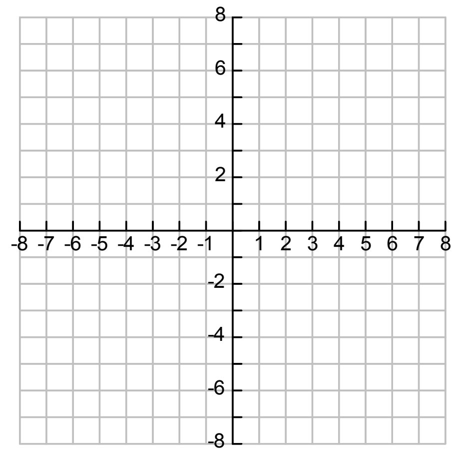
Unit 2: Linear Relationships

1. Graph the following line on the grid below by plotting the x and y intercepts. SHOW YOUR CALCULATIONS. State the intercepts as ordered pairs.

$3x + 2y - 12 = 0$

x-int: (,)

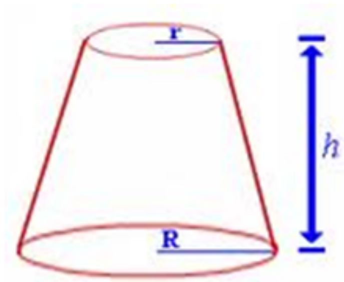
y-int: (,)



2. Determine the equation of the line that goes through C(4, -5) and is parallel to the line $2x - 10y + 90 = 0$

Unit 3: Measurement- Optimization

1. The object below is called a frustum. If r = 8 cm, h = 20 cm, and R = 12 cm, can you find its surface area?



hint: Extend the frustum until you create a cone. Then use proportions to find out total height of cone.

2. What is the maximum area of a rectangular horse paddock that can be enclosed with 160 m of fencing in each case? Draw a sketch of each situation.

   a) The yard is enclosed on all four sides.
   b) The yard is enclosed on three sides.

Appendix I – Applied Knowledge Tests

Unit 1: Rates & Ratios

1. Complete the following table:

Fraction in lowest terms	*Decimal*	*Percent*
$\frac{3}{32}$		
	0.45	

2. Alice bought 17 apples for $6.75. How many apples can he buy for $27.00?

3. Adam wanted to buy a shirt. It was regularly $67.00, but is on sale for 20% off. What is the sale price of the shirt?

Unit 2: Patterning

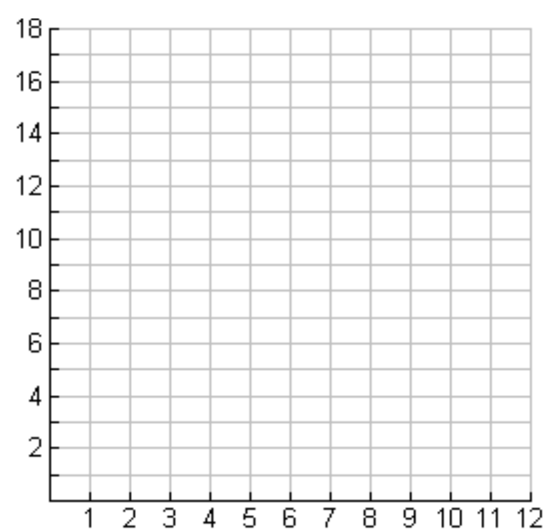
1. Find the first differences and then state the equation for this relationship.

Time (seconds)	Distance (m)
0	90
1	80
2	60
3	30
4	-10

Equation: ____________________

2. Graph the relation from the table of values below. **Label both axis**! Draw the line (or curve) of best fit for the data.

x	*y*
9	1.5
2	9
10	1
8	2
0	17
4	5
11	0.5



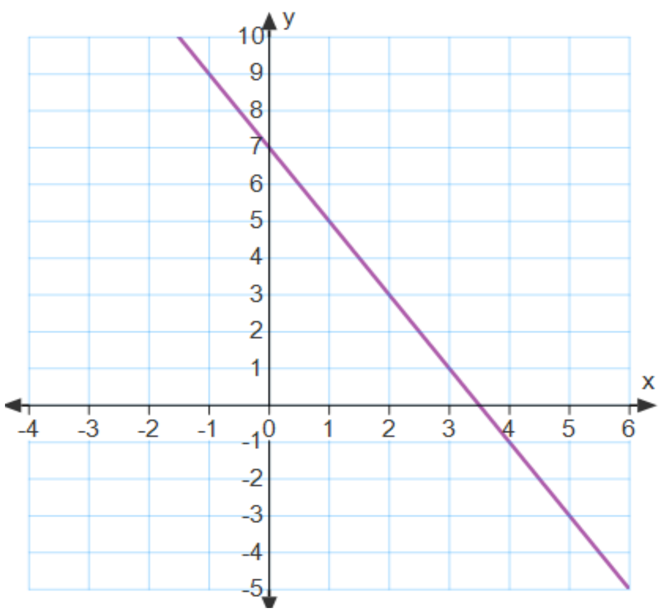
Unit 3: Linear Relationships

1. a) Determine the pattern rule for the pattern represented by this table of values.

   b) Predict the number of tiles in the 10^{th} position of this pattern.

position number, *x*	number of tiles, *y*
1	8
2	16
3	24

2. Fill in the table of values and then create the equation that represents the line.



x	*y*

Appendix J- Academic Blogging Questions

Topic #1: Slope

<table>
<tr><th>Question 1: Closed</th><th>Question 2: Open-ended</th></tr>
<tr><td>Hannah’s total pay includes a base salary and a percent of her sales.

The following table shows her total pay for three different sales levels.

<table>
<tr><th>Sales ($)</th><th>Total pay ($)</th></tr>
<tr><td>15 000</td><td>1700</td></tr>
<tr><td>17 500</td><td>1825</td></tr>
<tr><td>28 000</td><td>2350</td></tr>
</table>

Determine Hannah’s total pay when her sales are $47 000.

Justify your answer by showing work.</td>
<td>For safety reasons the slope of a ladder should be between 6.3 and 9.5.

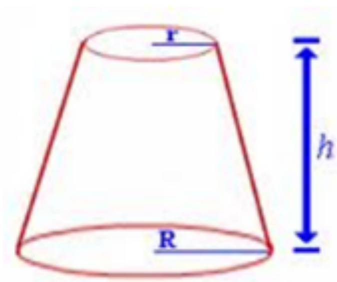
Give some circumstances where a ladder leaning on a wall would be safe for you to climb.

Justify your thinking by showing work.</td></tr>
<tr><td>Teacher Prompts:
-What is slope?
-How can you find slope?
-What is another way to describe percent of sales?
-What is Hannah’s base pay?
-How do you calculate the percent of something?
-Can you model this question with an equation?
-How can you ensure your answer is correct?</td>
<td>Teacher Prompts:
-What is slope?
-How do you calculate slope?
-Can you draw a picture of a ladder on a wall?
-Is there more than 1 correct answer?
-What do 6.3 and 9.5 in the question represent?
-What would the wall represent?
-What would the distance between the wall and the foot of the ladder represent?
- How far would the ladder need to be from the wall to be safe?
- How far up the wall can the ladder reach to be safe?</td></tr>
</table>

Topic #2: Linear Relationships

Question 1: Closed	Question 2: Open-ended
For safety reasons divers need to be aware of the pressure as they dive. At a depth of 4m, the pressure is 140kPa (kilopascals) and at 9m it is 190kPa. At what depth is the pressure double that at the surface?	The equation $C = 20n + 35$ represents the relationship between the cost of school volleyball uniforms, C, in dollars, and the number of uniforms ordered, n. • The uniform company requires that the school order a minimum of 15 uniforms. • The school has a maximum of $600 to spend on the uniforms. Determine possible values for n and C in this situation. Show your work.
Teacher Prompts: -What is slope? -What is a linear relationship? -Can you find the slope for this question? -Can you write an equation for this question? -What coordinates would you use in this question? -What depth is at the surface?	**Teacher Prompts:** -What is slope? -What is a linear relationship? -What does it mean by "possible values"? -Do you have to order 15 uniforms? -Do you have to spend all of the $600? -Is there only 1 correct answer? -How many different answers can you come up with? -How does this situation apply to real-life?

Topic #3: Measurement- Optimization

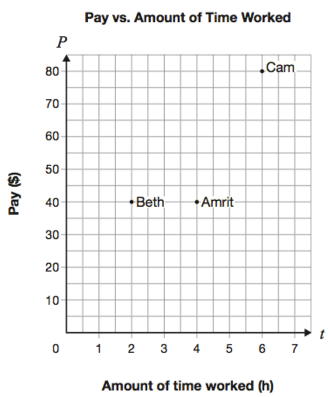
Question 1: Closed	Question 2: Open-ended
The object below is called a frustum. If r = 8 cm, h = 20 cm, and R = 12 cm, can you find its surface area?  **Hint:** Extend the frustum until you create a cone. Then use proportions to find out total height of cone.	A packaging consultant is designing a new package for selling candy. It can be any shape, but the surface area cannot be over $500cm^2$. What shape would you make the package? Justify your reasoning.
Teacher Prompts: -What is surface area? -What is the equation for SA of a cone? -What is the slant height? -What does proportions mean? -How are the cone and frustum related? -What is the different between r and R?	**Teacher Prompts:** -What is surface area? -What kind of things should you consider in making your choice? -What does maximize the capacity mean? -Why would you want to maximize the capacity? -Why would you choose one shape over another? -Can your answer to this question be wrong?

Appendix K- Applied Blogging Questions

Topic #1: Rates and Ratios

Question 1: Closed	**Question 2: Open-ended**
Gina is buying 24 oranges. Two stores offer the following deals: ▪ Store A: 12 oranges for $6.48 ▪ Store B: 5 oranges for $2.65 Gina can buy oranges individually. How much will Gina save if she buys 24 oranges at Store B? Show your work.	Which is the better deal?  Justify your answer.
Teacher Prompts: -How much does it cost for 1 single orange at each store? -What operations will you need to use in this question? -Can you represent this question as a picture? -Could you use a t-chart to solve this question? -What's the most efficient way to get the answer?	**Teacher Prompts:** -Are $20 and 20% related? -How do you calculate a discount? -Can you solve for each using an example? -If running shoes cost $89.99, which deal is better? -If a tv cost $2367, which is the better deal? -Is there only one correct answer? -Is there is situation where $20 off is better than 20%? (and vise versa?)

Topic #2: Patterning

Question 1: Closed	**Question 2: Open-ended**
Cam, Beth and Amrit are paid at an hourly rate for their time worked. The graph below shows the amount paid and the time worked for these three students.  Determine which student is paid the highest hourly rate. Justify your answer.	Can you create a pattern for this pile of blocks? 
Teacher Prompts: -What relationship is being shown on the graph? -What operation should you use? -Can you find out how much each person made in one hour? -Can you write an equation for each person's rate of pay? -What's the most efficient way to get the answer?	**Teacher Prompts:** -What is a table of values? -What would be in each column? -Can you estimate how many blocks are on the first layer? What about the top layer? -How do we estimate information? -Is there only 1 correct answer? -How many answers can you come up with? -Can you make an equation for your table of values?

Topic #3: Linear Relationships

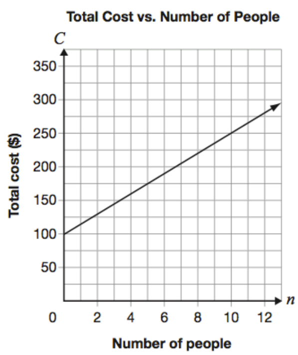
Question 1: Closed

The total cost of a banquet includes a fixed fee to rent the hall and a cost per person. Information about the total cost at two different halls is shown below.

Hall A

Number of people, n	Total cost, C ($)
10	275
20	450
30	625

Hall B



Which hall's total cost includes a lower cost per person?
Justify your answer.

Question 2: Open-ended

How long will this deodorant last?

Teacher Prompts (Question 1):

-How do you read a table?
-How do you read a graph?
-What is a linear relationship?
-Can you write an equation to write the relationship for hall A? Hall B?
-How much does hall A cost per person? Hall B?
-What operations will you use to solve this question?
-How can you check that your answer is correct?

Teacher Prompts (Question 2):

-On average, how long does 1 stick of deodorant last?
-Is there only 1 correct answer?
-Do people always use the same amount of deodorant?
-Could you create a table/ or graph for the relationship?
-Could you write an equation for this relationship?
-How many different answers can you come up with for this question?
-What is a non-linear relationship?
-Is deodorant use linear or non-linear?

Appendix L - Mathematical Communication Rubric

Sample Question:
For safety reasons divers need to be aware of the pressure as they dive.

At a depth of 4m, the pressure is 140kPa (kilopascals) and at 9m it is 190kPa.

At what depth is the pressure double that at the surface?

Criteria	Mathematical Criteria	Sample Answers
Level 0	Did not answer. Answer not relevant to the question. Just agreed with peer responses.	 I don't get this. True.
Level 1	Answer shows student understands the question. Answer given, with no explanation.	The equation is on the perimeter of y=10x+100.
Level 2	Selects a strategy to use, and tried to use it to answer the question. Cannot justify the strategy chosen.	So if the pressure of the surface is 100, the point where it doubles is 10m. 10 x 10= 100 + 100 = 200. The answer is 10 meters.
Level 3	Selects a strategy to use, and tries to use it to solve the question. Can justify the strategy chosen.	Pressure per metre. m=x2-x1 over y2-y1= 9-4 over 140-190= 5/50= 1/10. Therefore the pressure at the surface is 100kPa so to double the pressure you would have to reach a depth of 10m.

Level 4	Answer is correct. A strategy is used correct, with mathematical explanation and justification.	The depth is 2m at double the surface. I found out the slope since I know kPa is y value and the depth is x value. I found out the slope is 10. To find b value I plugged in the values in the y=mx+b equation. I got 100. So the equation is y=10x+100. I put 2 for the x value to get the double of the pressure. The answer was 120. y=120. 120-10x+100. I solved this equation and got 2m. So the depth is 2m. *(response to feedback)* Yes that is the first step. But the question is asking what is the depth when the pressure doubles.