1. Method

1.1 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).

1.2 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.

1.3 Participants

1.3.1 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.

1.3.2 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.

1.3.3 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.

1.4 Data Collection

1.4.1 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?	▪ Pre and Post 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

1.4.2 Surveys

1.4.2.1 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). 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.

1.4.2.2 Attitudes toward Blogging

A Likert-scale consisting of six, 5-point items was used to measure student attitudes toward using blogging in mathematics class after week one of blogging and 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 0.69 (pre-survey) and 0.86 (post-survey). 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).

1.4.3 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)

1.4.4 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.

1.5 Procedure

1.5.1 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

1.5.2 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.

1.5.3 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.

1.5.4 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.

1.5.5 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?"

1.5.6 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.

1.5.7 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.

1.6 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.