

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 education 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. Kojiri 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 response 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 than 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 persevere 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.