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How Social Presence on Twitter Impacts Student Engagement and Learning in a Grade 8 Mathematics Classroom

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Abstract

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MA, University of Phoenix Online, 2004

BS, McMaster University, 1998

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

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Abstract

Social media for personal use has evolved rapidly among adolescents, changing the way they communicate with each other. However, little research has been conducted about how teachers use social media in the classroom to improve student learning. The purpose of this qualitative study was to describe how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit. The conceptual framework was based on social presence theory developed by Short, Williams, and Christie. This qualitative study used a single case study design. Participants included 6 students and 1 classroom teacher in a Grade 8 mathematics course at a public middle school in a Canadian province. Data were collected from multiple sources including individual interviews, reflective journal responses from the teacher and students, documents such as course standards, and artifacts such as student tweets. Data were analyzed in the following way: interview and reflective journal data were coded for categories using the constant comparative method, and documents and artifacts were reviewed to identify emergent themes and discrepant data. Findings for this study indicated that Twitter had a positive impact on student engagement and learning of data management concepts. This study contributes to positive social change by providing a deeper understanding of how social media tools such as Twitter encourage students to create communities of learners to support each other during the learning process.

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Dedication

This dissertation is dedicated to my parents for their support and encouragement throughout my doctoral journey and helping me to meet all my professional and academic endeavors.

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I want to thank my dissertation chairperson, Dr. Debra Piecka, who has been an incredible source of guidance, support, and encouragement throughout my doctoral journey. Your thought-provoking questions challenged me to think more deeply about my research, and your sense of humor eased some of my stress on the toughest days. I also want to thank my methodology committee member, Dr. Deanna Boddie, for her guidance, advice, and assistance in helping me revise this document. Your attention to detail and your constructive feedback were valuable throughout the writing process. I am very grateful to both of you for your support, encouragement, and patience throughout the doctoral process.

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I would also like to express my gratitude to the classroom teacher and students who volunteered to participate in my study; without your contributions, I would not have been able to complete my study.

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Chapter 1: Introduction to the Study

The phenomenon of social media has altered the ways in which teenagers communicate, engage, and learn. Social networking platforms are the second most popular form of communication among teenagers; 29% of youth send messages through these sites (Lenhart, 2012). Approximately 80% of adolescents use Facebook and 40% report accessing this site several times a day to stay in touch with their friends (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013). However, teenagers have expressed a fading interest in using Facebook because of increased adult presence, and are now turning to platforms such as Twitter, Instagram, and Snapchat (Madden et al., 2013). Twitter is a micro-blogging tool that allows users to post messages of up to 140 characters to their followers, which can include people from anywhere across the globe. This network allows individuals to connect, communicate, and share with each other, creating what Marshall McLuhan (1964) referred to as a "global village." In the past, teenagers reported using Twitter to follow their favorite celebrities and receive news updates. However, they now report using Twitter to post their own content and follow their friends (Madden et al., 2013). One student, age 15 stated, “I mean, I could just tweet forever. There’s no limit on my tweets. Cause on Twitter like I express myself more, but at the same time, and like I said, I just do my thing.” Students enjoy using social media sites such as Twitter to share their opinions and thoughts and connect with their friends. Teen use of Twitter has increased from 16% to 24% since 2011. (Madden et al., 2013).

The term "global village" was coined by Marshal McLuhan, a Canadian philosopher, who predicted the World Wide Web thirty years before its inception

(McLuhan, 1964). McLuhan believed the world could be connected by an "electronic system" in which events in one part of the world could be experienced by other parts of the world, connecting everyone in the form of a "global village." According to Mittell (2011), Twitter is more akin to McLuhan's vision of a "global village" because any event, whether ordinary or significant can be communicated via Twitter. For example, people can interact with famous Hollywood celebrities no matter where they live and find information on political and economic news in different countries.

Even though teenagers use these social media sites for personal use, the integration of these tools is still relatively new in education. Researchers have conducted numerous studies about the use of Twitter in education (Andrade, Castro, & Ferreira, 2012; Antenos-Conforti, 2009; Blessing, Blessing, & Fleck, 2012; Borau, Ullrich, Feng, & Shen, 2012; Castrillo de Larreta-Azelain, 2007; Domizi, 2013; Dunlap & Lowenthal, 2009; Ebner, 2010; Elavsky, Mislan, & Elavsky, 2011; Evans, 2014; Fox & Varadarajan, 2011; Gunuc, Misirli, & Odabasi, 2013; Jacquemin, Smelser, & Bernot, 2014; Junco, Heiberger, & Loken, 2010; Junco, Elavsky, & Heiberger, 2012; Kassens-Noor, 2012; Lin, Hoffman, & Borengasser, 2013; Lomicka & Lord, 2011; Lowe & Laffey, 2011; McArthur & Bostedo-Conway, 2012; Pauschenwein & Sfiri, 2010; Prestridge, 2014; Rinaldo, Tapp, & Laverie, 2011; Tanner, Hartsell, & Starrett, 2013; Vazquez-Cano, 2012; Welch & Bonnan-White, 2012; Wright, 2010; Yakin & Tinmaz, 2013) but the majority of these studies are limited to higher education institutions (Andrade et al., 2012; Antenos-Conforti, 2009; Blessing et al., 2012; Borau et al., 2012; Castrillo de Larreta-Azelain, 2007; Domizi, 2013; Dunlap & Lowenthal, 2009; Ebner, 2010; Elavsky

et al., 2011; Evans, 2014; Fox & Varadarajan, 2011; Jacquemin, 2014; Junco et al., 2012; Junco et al., 2010; Kassens-Noor, 2012; Lin et al., 2013; Lomicka & Lord, 2011; Lowe & Laffey, 2011; McArthur & Bostedo-Conway, 2012; Pauschenwein & Sfiri, 2010; Prestridge, 2014; Rinaldo et al., 2011; Tanner et al., 2013; Welch & Bonnan-White, 2012; Wright, 2010; Yakin & Tinmaz, 2013). Only a small number of studies have been carried out in elementary and secondary school classrooms (Gunuc et al., 2013; Vazquez-Cano, 2012).

In a discussion about Twitter literacy, Rheingold (2009) maintained that social media in education encourages increased interest and engagement in learning and allows students to take more control and responsibility for their learning. However, in order to successfully incorporate social media tools such as Twitter into the classroom, Rheingold recommended that teachers be provided with professional development opportunities and the freedom to use social media in unique ways such as discovering what is happening around the world, meeting new people including other professionals to learn more about their field of study, and collaborating with others who have a shared interest. Taking a cue from Rheingold and others, I conducted this study to explore how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit.

This chapter is an introduction to this study. It offers background information that includes a brief summary of the research literature related to the scope of the problem, the problem statement, the purpose of the study, the research questions, and the conceptual framework. In addition, this chapter includes a brief description of the methodology of

the study, operational definitions, assumptions, scope and delimitations, limitations, and significance.

Background

My review of the literature indicated that social media tools such as Twitter can be integrated into classroom instruction for a variety of purposes such as enhancing communication skills, increasing engagement, building classroom community, meeting learning goals, and learning a foreign language. A number of studies have suggested that Twitter is an effective tool to enhance communication skills by generating discussions among students. Andrade et al. (2012), McArthur and Bostedo-Conway (2012), and Dunlap and Lowenthal (2009) found that inside and outside the classroom, students used Twitter to independently share resources, respond to each other's tweets, and communicate with their instructors. However, research also indicated that Twitter is often a passive, rather than active, communication tool. Lowe and Laffey (2011), Fox and Varadarajan (2011), and Lin et al. (2013) discovered that although students enjoyed sharing ideas, reading the tweets of their classmates, and voicing their opinions, questions tweeted by students were rarely answered, which resulted in little interactivity. In one of the only studies conducted in a K-8 setting, Gunuc et al. (2013) found that Grade 7 students did not enjoy using Twitter for communication purposes because their friends used Facebook to contact each other. In addition, students stated that Twitter does not have a "chat" feature, which is appealing because these conversations are private.

My literature review indicated that Twitter improves student engagement in the classroom. In Elavsky et al.'s (2011) study exploring the outcomes of Twitter use in a

large lecture hall, 78.2% of students reported they were more engaged in classroom activities because of the use of Twitter. Dunlap and Lowenthal (2009) found that students not only felt connected during the course, but continued to interact with each other through Twitter even after course completion. In other studies, researchers found that students also used Twitter to plan social events, share personal information with each other, and participate in university related activities (Junco et al, 2011; Evans, 2014). Junco et al. (2011) examined the effects of Twitter on the grades and instructional engagement of college students and found that students independently organized study groups using Twitter. On the other hand, Jacquemin et al. (2014) and Welch and Bonnan-White (2012) found that Twitter was not an effective tool to enhance student engagement in the classroom. In their study of Twitter use in an undergraduate biology class, Jacquemin et al. (2014) found that 100% of students did not view Twitter as a useful tool for engagement in the classroom, although 67% reported that Twitter provided exposure to relevant course information. In a study examining the use of Twitter to increase student engagement in university classrooms, Welch and Bonnan-White (2012) found no significant difference in engagement between the control group (no Twitter use) and the experimental group (Twitter integration); in fact, they found that the control group was more engaged than the experimental group. However, within the experimental group, students who enjoyed using Twitter reported higher levels of overall engagement.

My literature review also indicated a connection between Twitter and classroom community building. Wright (2010), Pauschenwein and Sfiri (2010), and Domizi (2013) found that integrating Twitter in the classroom helps teachers and students build a

positive classroom culture. Wright (2010) explored the use of Twitter in teacher education and found that students felt connected to their peers during their teaching practicum because they received tweets of support and encouragement. Pauschenwein and Sfiri (2010) examined the motivation of adult learners using microblogging during online training courses, and found that faculty members formed social bonds with each other through the use of Twitter even though they were from different higher education institutions. Domizi (2013) examined microblogging as a platform for fostering connections and community in a weekly graduate seminar course and discovered that building a sense of community helped students interact with each other and share resources more easily.

Researchers have generally found a positive relationship between Twitter and learning. Multiple studies have demonstrated that Twitter use helps students meet their learning objectives. In an investigation of Twitter use at the college level, Junco et al. (2010) discovered that students who used Twitter had significantly higher grades than the control group who did not use Twitter as part of the learning process. Blessing et al. (2012) and Tanner et al. (2013) discovered that the use of Twitter improved test scores in an undergraduate psychology class and a college algebra class, respectively. In a study of 15 first-year students in a university urban planning class, Kassens-Noor (2012) found that Twitter was more effective in knowledge creation than knowledge retention as evidenced by test results. Prestridge (2014) and Yakin and Tinmaz (2013) concluded that Twitter assisted students in meeting general learning outcomes. Prestridge (2014) found that students enrolled in a pre-service teacher education course started to tweet links to

articles, videos, and other visuals as well as additional resources as the course progressed, suggesting that active learning occurred. Similarly, in Yakin and Tinmaz's (2013) case study of Twitter use at the university level, the more students used Twitter, the more they began to express thoughts and opinions related to their learning. These studies demonstrated that Twitter can be used in the classroom to improve student learning outcomes.

Multiple studies have suggested that Twitter can be integrated into foreign language classes to improve literacy skills and an understanding of the target language's customs and traditions. Antenos-Conforti (2009) explored microblogging in intermediate Italian classes. Students reported that Twitter was beneficial in improving their written skills in Italian. Lomicka and Lord (2012) examined the use of Twitter in an intermediate level French course for university students to determine if the integration of Twitter helped to form a sense of classroom community. Lomicka and Lord found that students believed that using Twitter helped them learn the French language and understand the culture. Castrillo de Laretta-Azelain (2013) explored the use of Twitter among Spanish speaking university students in an initial-level German course to improve writing skills in German and discovered that 72.2% of students believed that using Twitter helped them improve their written skills in German. Faizi et al. (2014) conducted a survey with students across various disciplines at a university in Morocco and discovered that 81% of the students use social media tools such as Twitter and Facebook to learn another language so that they can interact more effectively with their peers and colleagues. In a foreign language blended classroom at a Chinese university, Borau et al. (2009)

determined from questionnaires that 70% of students found Twitter to be a useful tool for developing their English language skills.

Even though I found that Twitter plays a role in enhancing communication skills, increasing engagement, building classroom community, meeting learning goals, and learning a foreign language, I also identified several research gaps while conducting my literature review. Only two of the studies were carried out in K-12 environments. Gunuc et al. (2013) conducted a case study in which they explored seventh grade students' communication experiences with Twitter in Turkey and found the majority of students did not consider Twitter as an effective communication tool. Vazquez-Cano (2012) conducted a study with students ages 13-15 in a high school in Spain and found that the use of Twitter increased their linguistic competence and resulted in an increase on almost all indicators of the Spanish national assessments of key competencies in reading and writing. In short, I found only two studies that examined student use of Twitter in elementary and secondary classrooms, which indicates a definite gap in the research literature. More research thus needs to be conducted in elementary and secondary school classrooms to determine the potential role that Twitter can play in improving learning for students at those grade levels. For example, even though Gunuc et al. (2013) conducted a study with seventh graders to determine if Twitter is a useful tool for communication, students only tweeted for twelve days, which is not a sufficient amount of time to assess the instructional value of Twitter in a K-8 setting. Thus, additional studies need to be conducted about how Twitter can be used at the K-5 and the K-8 levels to enhance learning and communication among students. Therefore, I conducted this study to explore

how social presence on Twitter impacts student engagement and learning when a Grade 8 mathematics teacher integrates this social media tool into an instructional unit.

Problem Statement

Research indicates that using Twitter for instructional purposes in the classroom is current, relevant, and significant to the field of education. Adolescents from ages 12 to 17 have gravitated to social media tools in the last few years to communicate with their friends. As of 2012, approximately 30% of teenagers report using a social media site to stay in touch with their peers (Lenhart, 2012). The most popular social networking platforms are Facebook, Instagram, and Twitter (Madden et al., 2013). Created in 2006, Twitter use has gradually increased among teenagers; 24% now use Twitter, a figure that is up from 16% in 2011 (Madden et al., 2013).

Despite these statistics, little research exists which indicates that teachers use Twitter as an instructional tool to improve student learning. Instead, the classroom environment of most adolescents includes other types of digital tools. Purcell, Heaps, Buchanan, and Friedrich (2013) found that middle and high school English language teachers often require students to use desktop and laptop computers for learning purposes. However, these teachers have also increasingly incorporated technologies such as e-readers, tablets, and mobile phones into their instructional lessons. Purcell et al. (2013) also reported that these tools are mainly used for online research purposes, accessing assignments, and submitting assignments. Some teachers in this study also made use of more interactive online learning tools such as discussion boards and wikis. In a related study, Purcell, Buchanan, and Friedrich (2013) reported that 78% of teachers

found digital technologies, including social networking sites, useful when teaching writing skills because they helped students to be more creative in a variety of genres. Although a variety of digital tools have been used in English language arts classrooms, a lack of research exists about how social media tools, such as Twitter, are integrated into instructional units at the elementary and secondary school levels, even though these tools are becoming increasingly popular among this age group.

Little empirical evidence also exists about how teachers use social media platforms such as Twitter to improve student engagement and learning in core academic areas such as mathematics. Although several researchers have used social presence theory as a framework for their studies, this research has been conducted in higher education institutions and not in elementary and secondary schools. My study, therefore, contributes to the body of knowledge about the integration of social media to learn course content in mathematics by exploring how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit.

Purpose of the Study

The purpose of this qualitative case study was to describe how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit. To accomplish that purpose, I described how a teacher used Twitter to help students improve their learning in mathematics. In addition, I described how a teacher and students perceive the value of using Twitter to

improve learning in mathematics. I also explored how documents and artifacts such as tweets and problem solving notebooks supported student learning in mathematics.

Research Questions

The following research questions were based on the conceptual framework and my finding from the literature review for this study.

Central Research Question

How does social presence on Twitter impact student engagement and learning when a mathematics teacher integrates this social media tool into mathematics instruction?

Related Research Questions

1. How does a teacher use Twitter to help students improve their learning in mathematics?
2. How does a teacher perceive the value of students using Twitter to improve their learning in mathematics?
3. How do students perceive the value of using Twitter to improve their learning in mathematics?
4. How do documents and artifacts such as tweets and problem solving notebooks support student learning in mathematics?

Conceptual Framework

The conceptual framework for this qualitative study was based on social presence theory. Short, Williams, and Christie (1976) developed this theory, which is based on the premise that the social effects of a communication medium are predominantly caused by the degree of social presence of its users. The term "social presence" refers to the quality

of being present when two individuals are corresponding through a communication medium (Short et al., 1976). Short et al. hypothesized that "the users of any given communication medium are in some sense aware of the degree of social presence of the medium and tend to avoid using the medium for certain types of interactions" (p. 65). The essential factor in a communication medium, they contended, is the degree of "social presence" in that communication medium.

Social presence theory is also associated with computer-mediated communication. In earlier research about organizational communication, Conrad and Poole (1998) defined communication as "the process by which people interactively create, sustain, and manage meaning" (p. 15). Twitter is an example of computer-mediated communication. Computer-mediated communication includes interactions between individuals using two or more communication devices (DeVito, 2011). Examples of computer-mediated communication include friends exchanging texts and responses on their mobile devices, people responding to questions and statements in an online chat room, and Twitter followers posting their opinions, feedback, and replies through Twitter. Computer-mediated communication is interactive; it allows the individual to be a producer and consumer of information (DeVito, 2011).

Social presence theory has been used in several recent studies about how teachers have integrated Twitter into classroom instruction. Rinaldo et al. (2011) described how teachers use Twitter as a supplement to face-to-face interactions for students majoring in marketing because it allows them to develop social presence between and among students and the instructor in order to improve learning. Dunlap and Lowenthal (2009) explored

how Twitter could be used as a tool to enhance social presence in an online classroom to increase student engagement and found that students participated in problem solving exercises, brainstorming sessions, sharing resources, and collaborating for learning purposes. In an investigation of the extent to which microblogging fostered connections and community in a graduate seminar course on teaching and pedagogy, one of Domizi's (2013) objectives was to increase social presence among students in order to enhance learning and foster a sense of community in the classroom. Students reported that they felt more connected to their classmates and got to know their peers because of their presence on Twitter. Lomicka and Lord (2011) used social presence theory as a foundation in their study to examine how social presence is developed and maintained by students using Twitter to learn and communicate in an intermediate-level university French course. Lomicka and Lord found that the use of Twitter helped to build social presence which, in turn, helped students learn, share, and reflect. Using social presence theory, each of these studies revealed how Twitter fosters the development of student engagement, students' sense of classroom community, and student learning in online and face-to face courses.

For this study, I used social presence theory as the lens through which to examine the data I collected regarding how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit. I designed the student interview questions and reflective journal questions to discover how social presence impacted their learning of mathematical concepts. Further, I designed the teacher interview questions and reflective journal

questions to determine how she perceived the level of social presence in helping students to learn mathematical concepts. I analyzed the data using indicators related to social presence theory (i.e., affective, interactive, and cohesive categories).

Nature of the Study

I used an embedded single case study design to conduct this study. Yin (2014) defined a case study as an empirical inquiry that "investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident" (p. 16). Yin contended that a case study research design is a particularly good choice when a researcher wants to understand a contemporary phenomenon in a real-world setting and this understanding involves contextual conditions important to the case (Yin, 2014). Yin added that a case study inquiry:

> copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulation fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis. (p. 17)

Yin contended that the advantage of case study design is the use of multiple sources to present a rich picture of the case.

Merriam (2009) noted that a case study is a "bounded system, "and is often used to describe an "instance of some process, issue, or concern" (p. 41). Yin (2014) also defined the case as individuals, small groups, organizations, processes, and partnerships,

and, less frequently and more challenging, as communities, relationships, decisions, and projects. The case for this study was a Grade 8 mathematics course at the research site, and the unit of analysis was one instructional unit embedded in this single case or course. An embedded single case study design was particularly appropriate for this study because the purpose of this study was to explore how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into one instructional unit in a Grade 8 mathematics course.

In relation to the methodology, the participants of this study included the teacher of the Grade 8 mathematics course and the students who were enrolled in this course at a middle school in a Canadian province. I determined potential candidates for this study based on specific inclusion criteria, which I describe in Chapter 3. I selected teacher and student participants using purposeful sampling in order to obtain the richest data possible (Merriam, 2009). I collected data from several sources, including individual interviews with six Grade 8 students and the mathematics teacher, online reflective journals maintained by these same students and the teacher, documents such as instructional unit standards and outcomes, and artifacts such as tweets composed by participants and the mathematics notebooks they use to solve word problems.

I used social presence theory as the lens to conduct an analysis of the data at two levels. At the first level, I coded and categorized the data in relation to each question from the interviews and the reflection journals. I used line-by-line coding recommended by Charmaz (2006) for qualitative research for the initial coding, and NVivo software to organize and sort the data. I used a content analysis to review documents by explaining

the purpose, structure, content, and use of each document. At the second level, I examined the coded and categorized data to determine emerging themes and discrepant data which formed the key findings of the study. These indicators include the: (a) affective category (related to emotional behaviors such as the use of humor), (b) interactive category (related to interactions between participants such as continuing a discussion thread), and (c) cohesive category (related to behaviors associated with social functions such as using personal pronouns and group salutations; Rourke et al., 2001). I analyzed these findings in relation to the central and related research questions, and I interpreted them in relation to the conceptual framework and the literature review.

Definition of Terms

The following terms and phrases used in this study are defined as follows:

Blog: An online journal or diary maintained by an online user (Byrd, 2014).

Computer-mediated communication: Communication between people using a networked telecommunications environment. Twitter is a form of computer-mediated communication because it allows individuals to communicate using their computer or mobile phone (DeVito, 2011).

Closed-ended mathematics problems: Word problems that have only one answer, which can be generated by using more than one strategy (Small, 2012).

Direct message: A private tweet between two users; it is often abbreviated as DM. It is like an email or instant message (IM) that cannot be seen by other users (Twitter, 2014).

Favorite: Denoted by a small star icon, it shows the original user that another user liked their tweet. Users also use the favorite feature if they want to read the tweet at a later time because they do not have the time to read it immediately (Twitter, 2014).

Follower: A user who chooses to follow an individual in order to read his or her tweets and interact with that person (Twitter, 2014).

Hashtag: Used to categorize tweets by keywords; individuals use the symbol # before a key word or phrase to classify their tweets, so they can be easily found when conducting a search (Twitter, 2014).

Lists: A method to organize users who have the same interests. Users cannot interact with others using this feature (Twitter, 2014).

Mathematical concepts and skills for the instructional unit: For this study, the instructional unit on data management included the following skills: (a) collecting and organizing primary and secondary data, (b) displaying the data using a variety of forms, and (c) applying a variety of data management tools and strategies to make convincing arguments about data (Ministry of Education, 2005).

Mention: Denoted by the symbol @. When included at the beginning of a tweet, it is directed to a specific user, which other users cannot see (e.g., @username Hello. How are you?); however, if used in the middle or end of the tweet, it can be viewed by all followers of that user (e.g., What did you think of the movie? I thought @tcruise was amazing!) (Twitter, 2014).

Microblogging: A web service that allows users to compose and post short messages to other subscribers of that service (Merriam-Webster, 2014).

Open-ended mathematics problems: Word problems that have more than one correct answer, which can be generated using multiple strategies (Small, 2012).

Problem solving: In this mathematics classroom, the procedure or process used to solve a word problem to reach a solution (Small, 2012).

Profile: Considered the "homepage" which includes a user's biographical information, profile picture, number of followers, number of followees, and number of tweets (Twitter, 2014).

Retweet: Denotes the act of forwarding a tweet written by someone else to one's followers. It is abbreviated as RT (Twitter, 2014).

Social media: "Forms of electronic communication through which users create online communities" to share knowledge, opinions, thoughts, views, and a wide variety of content (e.g., articles, visuals, videos, etc.; "Social Media," n.d.).

Social presence: The quality of being present when two individuals are corresponding through a communication medium (Short et al., 1976).

Timeline: A user's timeline displays their tweets as well as tweets by their followers (Twitter, 2014).

Trending: A list of hashtags that are popular at any given time; these trending topics are highly visible on Twitter (Twitter, 2014).

Tweet: A message that is composed of 140 characters or less that is posted on one's timeline for their followers to read and respond to (Twitter, 2014).

Twitter: A free social networking and microblogging tool that allows users to create and post short posts (i.e., up to 140 characters) called tweets. Twitter members can

transmit tweets and follow other users using multiple devices (e.g., mobile phone, desktop computer). Users can also respond to the tweets that other users have composed (Twitter, 2014).

Assumptions

I made several assumptions in this research study. The first assumption was that the Grade 8 students and the mathematics teacher who participated in this study would respond honestly to the interview questions. This assumption was important because the experiences and perceptions that participants presented are considered valid and therefore impacted the credibility of this case study. My second assumption was that student reflection blogs were written by students themselves and not by a third party such as a parent or a sibling. This assumption was important because the thoughts and opinions of the blog posts also impacted the credibility of this study. My third assumption was that all tweets were composed and posted by students themselves, and not by a third party. This assumption was important because the content of the tweets and student responses to the tweets impacted the credibility of the study.

Scope and Delimitations

The scope of this study was a single case study of one Grade 8 mathematics classroom in a Grade 6-8 middle school located in a province in Canada. This case study was further narrowed or delimited by the participants, time, and resources. The sample size was purposefully delimited to students in this Grade 8 mathematics course because they met the minimum age requirements to use Twitter as independent users as outlined by Twitter's policy and guidelines rules (Twitter, 2014). This study was also delimited by

time because the duration of the mathematics instructional unit was 4 weeks during the 2014-2015 school year. Total time of data collection was 8 weeks including my interviews of participants, review of the reflective journals, and investigation of the artifacts. This study was also delimited to one Grade 8 mathematics course because I was a single researcher with limited time and financial resources.

Limitations

Limitations in a research study are generally related to the methodology. One limitation was related to the transferability of the results or findings of case study research. I conducted this study in a school system in a Canadian province in a suburban neighborhood where the parents of students reflect a middle- or high-class socioeconomic status. Therefore, the results from this case study may be different from the results of a case study conducted in an urban or rural community where poverty may be a significant factor. Transferability is thus limited to similar school districts with similar student populations.

Another limitation was related to the time frame in which this study was conducted. The instructional unit occurred over a 4-week period during which I collected documents, artifacts, and reflective journal responses. Teacher and student interviews were conducted after the instructional unit was complete. Total data collection took 8 weeks, which may not have been long enough to include the full extent of student experiences using Twitter to solve word problems in a year-long Grade 8 mathematics course.

Another limitation was that I was the only person responsible for all data collection, analysis, and interpretation. Consequently, the potential for researcher bias existed. In order to maximize objectivity and minimize bias, I used specific strategies to improve the trustworthiness of this qualitative research, including the strategy of reflexivity, which I describe in Chapter 3.

An additional limitation was the presentation of a single case. Yin (2014) contended that a single case does not allow for theoretical replication and only limited literal replication. Yin defined theoretical replication as the "selection of two (or more cases) in a multiple-case study because the cases are predicted to have contrasting findings, but for anticipatable reasons" (p. 241). Yin defined literal replication as "the selection of two (or more) cases within a multiple-case study because the cases are predicted to produce similar findings" (p. 239). Theoretical replication is not possible in a single case study because one case does not allow for contrasting results to be found. A single case study allows for some degree of literal replication because the singe case study can be replicated in a similar setting to corroborate results. It is possible to generalize from a single case study design; however, a multiple-case study design can reinforce these generalizations (Yin, 2014).

Significance

This study is significant in relation to the advancement of knowledge in the field, to practice in the field, and to contributions to positive social change. This research will make a difference in the field of educational technology because it advances knowledge about the impact of social media tools such as Twitter on student engagement and

learning at the middle school level. Researchers have conducted studies about how the use of Twitter engages, motivates, and improves student achievement in college and university courses. However, the results of these studies need to be replicated in new settings such as middle school or high school courses. This research advances knowledge in the field of educational technology by addressing a research gap about how students use social media tools to assist them in solving mathematical word problems.

This study is also significant because it contributes to instructional practice in the field of education. This study provides educators with a deeper understanding of how to integrate social media tools such as Twitter into an instructional unit to promote best practices. In addition, it may assist teachers in creating a community of learners in the classroom who help and support each other in learning course content.

This study also contributes to positive social change. As a social media tool, Twitter has the ability to connect students outside of the traditional classroom setting. Integrating this social media tool into classroom instruction can build an online community of learners who learn from each other. Twitter can affect positive social change by allowing students to build relationships that can be developed as they learn course content, support each other during the learning process, and share their ideas, thoughts, and opinions through discussions. Building relationships on Twitter also enhances face-to-face interactions in the classroom, which makes learning more effective and valuable. Students also learn to build and maintain their own personal learning network on Twitter, which can lead students to connect with professionals from various subject areas to deepen their learning. Teachers can also connect their classroom with

another classroom on Twitter, which can form an online global community of learners who support each other during the process of learning course content.

Summary

This chapter was an introduction to the study. The background section included a summary of research studies on the integration of Twitter into classroom instruction in order to enhance communication and engagement, build classroom community, and meet course objectives. The relevance of the problem and the purpose of this study were also described. The purpose of this qualitative case study, as reflected in the central research question for this study, was to explore how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this tool into an instructional unit. In addition, the methodology of this study, including the rationale for selecting a single case study design, was presented. The assumptions related to this study were also presented, which included the importance of honest responses from participants in order to present a credible study. In addition, the scope and delimitations and limitations associated with the methodology, and the significance of this study in relation to advancing knowledge, changing practice in the field, and affecting positive social change were presented.

In the next chapter, I review the scholarly literature, and describe in more detail the theoretical foundations and the conceptual framework for this study. I analyze current research in relation to Twitter integration in courses at the elementary, secondary, and college and university levels. I focus specifically on the use of Twitter in enhancing student communication skills and engagement, building classroom community, and

improving student learning. The chapter concludes with a discussion of the themes and gaps that emerged from this review.

Chapter 2: Literature Review

The phenomenon of social media impacts the ways in which people communicate, share, and learn. Tools such as Twitter, Instagram, Facebook, Snapchat, Pinterest, and Vine allow people to share information, images, and videos with each other. Twitter has become one of the most popular microblogging tools with more than 255 million users worldwide posting an average of 500 million tweets per day (Ajmera, 2014). The majority of Twitter users access the app through their mobile devices (Bullas, 2014). Teenagers in particular are drawn towards these social networking sites to keep in touch with their friends (Madden et al., 2013). Approximately 95% of teenagers are online and the majority of them use online tools for social interaction (Pew Research Internet Project, 2012). The majority of young adults age 12-29 spend time online, and smartphone use among this age group has increased quickly, from 23% in 2011 to 37% in 2013 (Madden et al., 2013). According to the Pew Research Internet Project, texting is the most popular form of communication tool for teenagers; 63% of adolescents age 12-17 text daily and 78% have their own cell phones (Madden et al., 2013). Email, therefore, is no longer the main form of communication; 54% of teens age 12-17 reported that they do not use email anymore (Lenhart, 2012). Social networking platforms are the second most popular form of communication between teenagers; 29% of youth send messages through these sites (Lenhart, 2012). Twitter use has gradually increased in the last few years among this age group, from 16% to 24% since 2011 (Madden et al., 2013). Although instructors have incorporated Twitter into higher education settings to motivate and engage students and to achieve learning objectives, a significant lack of research

exists on the integration of this social media tool into instruction in elementary and secondary schools. Because adolescents are using social media and other technology tools to communicate and connect with each other, educators need to find creative and innovative ways in which to bring these tools into the classroom for relevant learning opportunities. Therefore, the purpose of this qualitative research study was to explore how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit.

This chapter includes a review of the literature, organized according to the following topics: (a) an explanation of the research strategy that I used, (b) the conceptual framework, (c) research-based definitions of Twitter, (d) a review of research related to the integration of Twitter into classroom instruction, (e) a review of research related to the benefits and challenges of using Twitter in instruction, (f) studies of social media using case study methodologies, and (g) a summary and conclusion, including a discussion of emerging themes and research gaps.

Literature Search Strategy

I used several strategies to conduct this literature review, and used the following databases to locate peer-reviewed articles: Academic Search Complete, Education from Sage, Education Research Complete, ERIC, Google Scholar, and Thoreau. Additionally, for articles that were difficult to locate, I used the Walden Library Document Delivery Service. In these databases, I searched for the following terms: *Twitter, social media, social networking, classroom, education, math, elementary classroom, secondary classroom, engagement, motivation, learning, communication*, *social presence*, and

microblogging. Because a shortage of scholarly studies on the integration of Twitter into instruction at the elementary and secondary school levels exists, I included studies that examined the incorporation of Twitter into instruction in college and university classrooms.

Conceptual Framework

This research study was grounded in the conceptual framework of social presence theory within the context of social media. Short, William, and Christie developed social presence theory in 1976, and defined social presence as "the degree of salience (i.e., quality or state of being there) of the other person in a mediated communication and the consequent salience of their interpersonal interactions" (p. 65). A communication medium that has high social presence (e.g., video such as Skype) is considered warm and personable while a communication medium that has low social presence (e.g., audio such as a podcast) is considered unfriendly and distant. In short, communication mediums are different in terms of their level of social presence, and consequently the quality of interaction that occurs when using these communication mediums is also different (Short et al., 1976).

Social presence theory is associated with computer-mediated communication, which is a form of communication between two or more people who interact with each other through online networks (DeVito, 2011). From the perspective of Short et al. (1976), any text-based computer-mediated communication would have low social presence; face-to-face communication would be considered to have the most social presence. In a face-to-face learning environment, students have the benefits of visual and

verbal cues so that they are aware of each other. However, education has now evolved to include online learning environments where there is a lack of face-to-face interactions and the inability to rely on body language and facial expressions when communicating. Therefore, social presence theory has assumed more prominence in distance education in order to enhance student learning. In this study, I used the affective, interactive, and cohesive categories (Rourke et al., 2001) related to social presence to analyze the data from the interview questions, the reflective journal questions, and student and teacher tweets.

Several researchers have explored and extended Short, Williams, and Christie's work on social presence theory. Gunawardena (1995), for instance, explored social presence theory in relation to implications for interaction and collaborative learning in computer conferences. Gunawardena conducted two studies with graduate students in which they discussed issues related to distance education in computer conferences via computer-mediated communication. In both studies, students noted that computer-mediated communication was stimulating and interactive. In another study, Gunawardena and Zittle (1997) explored social presence as a predictor of satisfaction with a computer-mediated conference environment by conducting a study with 50 graduate students from five universities in the United States who participated in a virtual conference to discuss their research projects. They found that high social presence was a strong predictor of increased student satisfaction when emoticons were used during discussions.

In another study of, critical inquiry in a text-based environment in relation to computer conferencing in higher education, Garrison, Anderson, and Archer (2000)

conducted a content analysis of web-based conferencing transcripts and identified three main features that support online learning: cognitive presence, teaching presence, and social presence. Garrison et al. referred to this as the community of inquiry model. Rourke, Anderson, Garrison, and Archer (2001) also assessed social presence in text-based computer conferences and, using content analysis of two online class discussions, identified three categories of social presence: affective responses, cohesive responses, and interactive responses. Affective responses, Rourke et al. noted, are responses that consist of personal messages of emotions and feelings. Cohesive responses are messages that contain greetings, salutations, and social sharing. Interactive responses are responses where participants acknowledge and respond to each other's postings on a discussion board.

In another study, Tu (2000) examined online learning migration in a computer-mediated communication environment. Tu emphasized the importance of social presence for learning due to the increased integration of computer-mediated communication in education. In particular, Tu recognized the important role of course design in developing social presence in online courses. Using components of Bandura's social learning theory, Tu identified three dimensions of course design that affect the development of social presence in distant education courses: (a) social context, (b) online communication, and (c) interactivity. Social context "contributes to the degree of social presence and includes task orientation, privacy, topics, recipients/social relationships, and social processes" (Tu, 2000, p. 3). Tu noted that “online communication” refers to the language that students use to express themselves in an online environment and “interactivity” refers to the extent

and timeliness of communication between participants. Tu concluded that social presence is a vital component in explaining how social interactions affect learning in online course discussions.

In a similar study, Tu and McIssac (2002) examined the relationship of social presence and interaction in an online learning environment and found that increased social presence led to increased student interactions. These interactions, Tu and McIssac recommended, can be fostered by taking into consideration the characteristics of the learner and an appropriate computer-mediated communication platform.

In another study about social presence, Picciano (2002) used survey items similar to those used by Gunawardena and Zittle (1997) and Richardson and Swan (2003) in order to investigate the relationship between perceived social presence, interactions, and learning for students enrolled in an online graduate education course. Picciano found strong correlations between the three variables as well as significant differences between the degree of social presence and written assignments. Students who perceived a high level of social presence scored higher on written assignments than students who perceived a medium level of social presence. Students who perceived a medium level of social presence in turn scored higher on written assignments than students who reported a low level of social presence. Picciano found no correlation between student perceptions about the degree of social presence and their scores on achievement tests.

Richardson and Swan (2003) examined social presence in relation to student perceptions about learning and satisfaction in online courses. They also found a relationship between social presence and student enjoyment. They adapted the version of

the social presence survey instrument that Gunawardena and Zittle developed, and found that students who perceived a high level of social presence in a distant education course were more satisfied with their instructor than those students who perceived a low level of social presence in the online course. Additionally, students who perceived a higher level of social presence also believed they learned more from the course than students who reported low levels of social presence.

In another study related to social presence theory, Swan and Shih (2005) used survey measures and techniques that Gunawardena and Zittle (1997), Richardson and Swan (2003), and Picciano (2002) developed to investigate the relationship between student perceptions of social presence and their satisfaction with graduate online courses in educational technology. Quantitative results indicated a significant correlation between students' perceptions about social presence and their satisfaction with the online course. In particular, Swan and Shih discovered that teacher presence is a greater predictor of satisfaction than the social presence of their classmates. Swan and Shih also found that students who perceived a high level of social presence identified online discussions as useful and effective.

Several researchers, conversely, have used social presence theory as a foundation for their research studies. Dunlap and Lowenthal (2009) examined the use of Twitter to increase social presence in online instructional design and technology courses because they found the use of other activities (e.g., online games, promoting discussions on non-academic topics, and generating captions for silly photographs) did not promote a higher level of social presence. Domizi (2013) examined the use of microblogging to foster

connections and community in a graduate course and noted the importance of finding relevant and appropriate tools such as Twitter to enhance the perception of social presence in a multidisciplinary graduate seminar course focused on pedagogy and course design. Lomicka and Lord (2011) examined the development of social presence through the use of Twitter as a communication tool in an intermediate level French course at a university in the United States. They found that Twitter helped to build classroom community and social presence because students built relationships, which in turn made them more comfortable tweeting information and opinions in the target language.

Even though social presence theory is accepted in online education and has been used as a foundation in face-to-face classrooms in higher education institutions (Domizi, 2013; Lomicka and Lord, 2011), this theory has not been explored in relation to the use of Twitter in elementary and secondary education classrooms. In these classrooms, learning occurs predominately face-to-face in a traditional classroom setting. Because of the increased use of social media tools by students at the elementary and secondary school levels, teachers need to consider integrating these tools into classroom instruction in order to enhance learning and interactions between and among students. Therefore, social presence theory formed the foundation of this research study, and the three categories of social presence theory that Rourke et al. (2001) identified, which include the affective, interactive, and cohesive, were used to interpret the findings of this study.

Twitter Defined

Twitter is a microblogging social media network of real time posts that are limited to 140 characters or less (Twitter, 2014). Launched in 2006, Twitter was initially

intended to answer the question, "What are you doing?" However, now Twitter is more about "What is going on?" This social media tool has emerged as a source of discovery, with a focus on sharing information that is current and relevant and engaging in conversations with other individuals (Lowe & Laffey, 2011). Due to the evolution of its use, Twitter is now considered more of a news source and learning resource than a social media platform. Twitter users now utilize it mainly to ask questions and to share information and opinions with a global audience (What is Twitter, 2010). In other words, people use Twitter for conversations based on their work, ideas, and interests, often in a global context.

Twitter turned eight years old in March 2014 and it has become popular with people and organizations across various fields. Movie stars and TV actors use Twitter to connect with their fans; news outlets use Twitter to report current events and issues, and sports organizations use Twitter for contests and updating scores (Asis, A, 2013; DexMedia, 2014). At the 2014 Oscars, host Ellen DeGeneres tweeted a 'selfie', which included a number of Hollywood stars and it garnered 3.4 million retweets, which demonstrates the power of this social media tool (DeGeneres, 2014). Twitter has been influential in many disciplines from sports to Hollywood and from the news industry to businesses and corporations. However, Twitter's place in education is relatively unexplored.

In the field of educational technology, Twitter is considered a complicated yet promising tool for use in the classroom. Due to privacy concerns, many educators are hesitant to use Twitter because it is a public forum; tweets can be seen by anyone who

follows a person's tweets unless the user sets up restrictions on his or her account (Rinaldo et al., 2011). However, Twitter is increasingly used to enhance learning that teachers require as homework outside of the classroom. Teachers can create a classroom account based on the subject(s) they teach and they can tweet reminders, announcements, homework, and links to videos and articles about concepts that students need to learn (Dodd, 2012). Teachers can also use Twitter to ask questions based on discussions that they conduct in their classrooms, thus initiating conversations between students to deepen their learning. Twitter can be used to create polls where students either select 'favorite' to denote agreement or select 'retweet' to indicate disagreement with the poll questions (Brower, 2009).

In order to understand how Twitter is defined, it is necessary to understand how Twitter works. Twitter users sign up through the online website (www.twitter.com) with a username, also known as a 'handle' (e.g., @username), and a password. They then compose tweets, which are read by their 'followers'. Followers can either 'retweet', 'favorite', or both. However, the term 're-tweeting' does not necessarily mean that the follower endorses the tweet; rather he or she will 'retweet' in order to bring awareness to the content of the tweet. Tweets can also be directed to someone in particular where the tweet begins with @username and then is followed by the message intended for that recipient, which only he or she can see. On the other hand, the @username can also be in the middle or at the end of the tweet, which is referred to as a 'mention; these tweets can be seen by all followers of that user. In addition, Twitter also allows private direct messages to be exchanged between users; the caveat is that individuals must follow each

other in order to send a direct message. Twitter allows lists to be created as well; these lists are based on users who share common interests and passions. These lists can be public or private just as a user's account is public or private. This social media tool has evolved to include weekly and monthly chats in which people will tweet about a topic of interest using a hashtag (Cooper, 2013). For example, I host a monthly chat for mathematics teachers in the school district where I work. These monthly chats provide mathematics teachers with the opportunity to discuss pedagogy and instructional practices related to mathematics. Twitter is further strengthened by the fact that links to articles and videos on the World Wide Web are shortened to 22 characters, which increases its effectiveness for educational purposes because it allows a user to use more characters for their message (Ciserno, 2014).

Twitter, therefore, is a powerful social media platform allowing individuals from a variety of professions to learn from each other, share information, and examine issues from a variety of perspectives through productive discussions. Twitter is also used for social purposes, in which, users will communicate with their favorite celebrities as well as following their favorite sports team in order to stay current with team scores and statistics. Due to its popularity, elementary, secondary, college, and university classrooms have been integrating Twitter into their classrooms in a variety of ways such as conducting discussions on course content, posting homework, and links to additional resources to enhance learning. Due to Twitter's many features, teachers need to provide guided instruction about these features in order to help students use this social media tool effectively both inside and outside the classroom.

Twitter as a Communication Tool

The research literature establishes a connection between the use of Twitter in the classroom and the types of communications and interactions that occur between students and their instructors. In particular, Twitter serves as a valuable informal tool for sustained interaction and communication. Some researchers have explored how this social networking platform is used for communication beyond the four walls of the classroom such as posting learning resources, class assignments, and reminders (Lin et al., 2013; Lowe & Laffey, 2011; Rinaldo et al., 2011); facilitating class participation and providing opportunities for students to share their opinions with the rest of the class (Andrade et al., 2012; Fox & Varadarajan, 2011). In Lowe and Laffey's (2011) study, a college professor used Twitter in a postgraduate marketing course of 123 students to encourage student introspection by posting information on recent marketing events, contemporary marketing issues, critical concepts discussed in class, and issues related to these concepts. During this 8 week study, students accessed the instructor's tweets and exchanged ideas with each other and the instructor about course material. Lowe and Laffey reported that students found Twitter to be helpful and it allowed them to make connections between what they were learning and real-world examples. However, Lowe and Laffey found interactivity between students was limited, which they believed could be due to the novelty of Twitter as a tool in the classroom and the large number of students in the class. Lowe and Laffey concluded that a lack of anonymity could be another possible reason for minimal interaction between students because some students might be more reluctant

than others to tweet, similar to their tentativeness in participating face-to-face with other students in a traditional classroom.

In a study that included 131 second-year pharmacy students, Fox and Varadarajan (2011) discovered that 71% of students found Twitter distracting and 69% thought it prevented note taking; however 80% stated that using Twitter facilitated class participation and provided the opportunity to voice their opinions and share ideas. Nevertheless, students also reported that questions they tweeted were seldom answered by the professor or other students, confirming results from Lowe and Laffey's study that Twitter seems to be a more passive form of communication for students (Fox & Varadarajan, 2011). It is interesting to note that in Lowe and Laffey's (2011) study, students tweeted using their real names yet in Fox and Varadarajan's (2011) study, students were assigned an anonymous username using locally developed software called 'SmartAlias'. Even though similar results were found despite this key difference, the difference could be attributed to the novelty factor of using Twitter for educational purposes. Additionally, since students enrolled in higher education classes only meet a few times a week, a lack of connections among students could result in less interactivity. Furthermore, in both studies, students were given a short demonstration of the features of Twitter and no explicit directions on what to tweet; instead they were required to tweet a certain amount of times. Students also expressed anxiety over the large number of tweets due to large class sizes. Perhaps if more directions were given and more time was built in to become comfortable with this tool, different results might have been found.

Similar results were found in Lin et al.'s (2013) case study about Twitter use. Students enjoyed reading the tweets of others but seldom retweeted or responded to the tweets of their classmates confirming the results from Lowe and Laffey's (2011) and Fox and Varadarajan's (2011) study that Twitter is considered a passive communication tool in which little collaboration and interactivity occurs among students. Unlike the studies conducted by Lowe and Laffey and Fox and Varadarajan, Lin et al.'s (2013) study did not provide an introduction on how to use Twitter. However, all three studies are similar in that scaffolding or clear learning goals were not outlined; instead students were told they had to tweet a certain number of times including 75 tweets for the semester (Lin et al., 2013) and four tweets per week (Fox & Varadarajan, 2011). Lowe and Laffey (2011) only required students to follow the tweets of their instructor; they were not required to compose any tweets.

In a related study, Lowe and Laffey (2011) described how a professor used Twitter to post information regarding a variety of marketing concepts and issues and they found that students were not actively engaged in terms of communicating with each other or the instructor. Student interactivity might have been enhanced had the instructor posted questions and polls on a regular basis to which students had to respond. Furthermore, it was not clear what information was included in the "Twitter Briefing" that the professor provided before Twitter was integrated into classroom instruction. Perhaps if the professor had provided detailed information to students about how to use Twitter effectively, the study might have yielded different results. In addition, perhaps a practice session would have assisted students in becoming familiar with Twitter so they

would have been able to use it more successfully during the time in which the professor posted tweets.

In contrast, researchers have conducted other studies in which students were actively involved in using Twitter when they were invited to share information and resources with the class and encouraged to interact with each other and the instructor (Andrade et al., 2012; Dunlap & Lowenthal, 2009; McArthur & Bostedo-Conway, 2012). Dunlap and Lowenthal (2009) conducted a study in which the teacher encouraged students in an online instructional design and technology course to use Twitter as part of their classroom experience. Dunlap and Lowenthal found that students in both classes were able to engage in collaboration, information sharing, brainstorming, and problem solving. For example, one student had a question about a concept from the textbook, sent a tweet, and received three responses within ten minutes. Another student watched a news story on federal funding in higher education and expressed her views through a tweet. Practicing professionals not affiliated with the course also sent feedback and responses to students via tweets, which allowed students to see the relevance and value of using Twitter as a learning tool.

Several researchers have found that Twitter is a passive form of communication whereas other researchers have found that Twitter promotes interactions between students and between students and their instructor. The difference in results between Dunlap and Lowenthal's (2009) and Lowe and Laffey's (2011) studies could be because the number of students who participated in Dunlap and Lowenthal's study was not provided. It is possible their classes were small, thus attributing to increased interactivity and

communication among students. Furthermore, because Dunlap and Lowenthal were the instructors for the technology courses that they examined, students could have been more open to using technology in general. Rinaldo et al. (2011) also discovered that after the professor tweeted about current issues related to various companies, those companies started to follow the professor. Rinaldo et al. also found that the students in this consumer behavior class began to follow these companies and proceeded to share what they learned from their tweets with the rest of the class including the professor.

McArthur and Bostedo-Conway (2012) found similar results to Dunlap and Lowenthal (2009). McArthur and Bostedo-Conway explored the relationship between student-instructor interaction on Twitter and student perceptions of teacher behaviors. They found that students who are active on Twitter and follow their instructor perceive their instructor to be more knowledgeable, approachable, and interactive than they would otherwise. McArthur and Bostedo-Conway concluded that Twitter may be a promising option for enhancing instructor-student relationships and communication between them. Even though students from Dunlap and Lowenthal's study continued to communicate with their peers and their instructor after the course was completed, this trend did not occur in the McArthur and Bostedo-Conway study.

In another study, Andrade et al. (2012) examined cognitive communication in higher education when a professor integrated Twitter use into a PowerPoint presentation during lectures given to masters' level students in Portugal. Andrade et al. measured the potential of Twitter use across six dimensions that included (a) pedagogical aspects, (b) technological aspects, (c) cognitive learning, (d) classroom interactions, (e) positive

behaviors in the classroom, and (f) negative behaviors in the classroom. Students could ask and answer questions, vote on the issues presented, and answer multiple choice questions. Andrade et al. found that students participated in cognitive communication because they were involved in commenting, questioning, and debating the concepts that the instructor presented. However, it is not clear if students were give an introduction to Twitter or if data were provided on how many students already had a Twitter account. In addition, convenience sampling was done, which may have affected the outcome of the study because convenience sampling was not representative of the population.

For this literature review, only one team of researchers explored students' communication experiences with Twitter in an elementary school classroom; however, this study was conducted in Turkey. Gunuc et al. (2013) explored the perceptions of Grade 7 students who used Twitter as a communication tool. Data sources included (a) a questionnaire, which used open ended questions, (b) semi-structured interviews, and (c) documents. Results indicated that 67% of the students did not find Twitter an interesting tool for communication and 76% stated that none of their friends used Twitter for interacting with others. Comments included statements such as "Besides, since most of my friends don't use Twitter, I would rather use Facebook for messaging." (p. 449); "I do not intend to use Twitter for communication" and "It is not as good as the telephone for communication" (p. 450). Similar to other studies, instructors provided no introduction to Twitter use or discussed the benefits of Twitter. Additionally, students tweeted to each other and researchers for 12 days, which is not a sufficient amount of time to determine Twitter's effectiveness in improving students' communication skills. Students also

reported the lack of a chat feature in Twitter to engage in private discussions. However, students did not seem to realize that sending direct messages to each other could initiate a private conversation. Furthermore, students stated they prefer social media platforms where they can engage with audiovisual materials, yet they failed to realize that they can attach links to visuals and videos in their tweets. This evidence gives credence to the fact that students need explicit instruction on how to use Twitter to take full advantage of its features. Although students found the 140 character limit restrictive, this restriction also helped students to compose succinct messages as well as to create short-hand for key words in order to write and post their messages in 140 characters or less. Because students found Twitter to be a sharing platform rather than a communication platform, a clear delineation between social conversations and academic conversation platforms might be beneficial because this study did not require students to tweet to meet course learning objectives.

In summary, research has shown that a microblogging tool such as Twitter is designed for both online and offline communication formats. Individuals can have real-time conversations with another person or post a tweet to be answered at another time. This type of environment is suitable for designing social learning experiences to increase learning opportunities and communication among students. However, research studies have also demonstrated that Twitter can be viewed as a passive form of communication especially when students are not familiar with the platform or if class size is large because students may become overwhelmed by the numerous tweets posted every day.

Twitter as an Engagement Tool

A review of the literature demonstrates that Twitter plays a role in student engagement. Researchers determined that when Twitter is integrated into instructional practice, students participate at a higher level than they normally would (Dunlap & Lowenthal, 2009; Ebner, 2010; Elavsky et al., 2011; Evans, 2014; Junco et al., 2011: Welch, 2012). In other words, students develop relationships and connections they otherwise would not have because they use Twitter. Elavsky et al. (2011) explored the use of Twitter during one semester of a university course on the role of media in a democracy with an enrolment of 250 students. Although the teacher provided instructions on how Twitter works, the teacher did not provide direction on how it could be used in relation to the class (Elavsky et al., 2011). Results indicated that 78.2% of students found Twitter increased their engagement within the course; however, over 60% stated that they could not see themselves using Twitter following course completion (Elavsky et al., 2011). These results contradict Dunlap and Lowenthal's (2009) findings that students in online instructional design and technology courses continued to engage with each after the course ended. In a study about the outcomes of Twitter in a large lecture hall, Elavsky et al. (2011) did not explore reasons why students said they would not continue to use Twitter as a tool after the course was completed. Therefore, an assumption could be made that students who explore the role of mass media in fostering democracy should be motivated to use a tool like Twitter to learn course concepts, share ideas, and engage in conversations.

Other researchers have also investigated the relationship between Twitter and classroom engagement. Evans (2014) investigated the role of Twitter in a 12 week undergraduate business and management class and found that the more students used Twitter, the more engaged they felt, as indicated by a Pearson coefficient of 0.55. These students reported that they were more likely to participate in university related activities, plan social events, and share personal information with others. These results correspond with Junco et al.'s (2011) study about assessing outcomes for student collaboration, engagement, and success in relation to Twitter use. Junco et al. found that Twitter increases engagement because students independently organized study groups and contributed ideas related to arranging extra-curricular activities. However, a causal relationship could not be determined because it is not known if students who are more engaged in their learning will make better use of Twitter or if their increased use of Twitter will cause an increase in their engagement.

Different results were found in the studies that Jacquemin et al. (2014) and Welch and Bonnan-White (2012) conducted. In their study of undergraduate students enrolled in two sections each of introductory sociology and anthropology courses, Welch and Bonnan-White (2012) discovered no significant difference between the control group (i.e., Twitter was not integrated into the class) and the experimental group (i.e., Twitter was incorporated into the class) in terms of engagement due to the use of Twitter. In fact, Welch and Bonnan-White found that the control group reported higher levels of engagement than the experimental group in the following dimensions: (a) overall engagement, (b) academic engagement, (c) peer engagement, (d) intellectual engagement,

and (e) beyond-class engagement. However, they also found that students who enjoyed using Twitter in the experimental group reported higher levels of overall engagement on all five dimensions than those students who did not enjoy using Twitter. Again, a causal relationship could not be determined, but students expressed difficulty and unfamiliarity with the technology in addition to "log-in overload" in terms of creating yet another social media account (Welch & Bonnan-White, 2012).

Similarly, Jacquemin et al. (2014) conducted a study about Twitter use in the higher education classroom that included 22 undergraduate students and 16 graduate students enrolled in biology courses. Of these students, 67% believed that Twitter exposed them to relevant information on their subject matter, but they did not consider Twitter a valuable tool that teachers should use to integrate into classroom instruction. Jacquemin et al. also reported that student use of Twitter failed to facilitate any type of discussion and therefore no engagement occurred. These results could be attributed to student beliefs that Twitter as a social media tool is only useful for social interactions. In addition, biology courses might not be conducive to Twitter use like courses in marketing, communications, and business where discussions are more conducive in terms of course content.

In summary, research has demonstrated that teachers are able to use Twitter in the classroom to enhance student engagement. Students have been found to independently create study groups, organize off-campus social events, and share personal information with each other. Some of these students even continue to communicate with each other via Twitter after course completion. However, research has also indicated that

students in some disciplines such as biology do not find Twitter conducive in promoting engagement due to the nature of the course content and the belief that Twitter should only be used for social interactions.

Twitter as a Classroom Community Building Tool

The findings of some studies reveal how teachers could use Twitter to build a sense of community with their students in the classroom. Several researchers discussed the challenges of building a classroom community in order that students can feel connected to each other, their instructor, and the course content (Domizi, 2013; Pauschenwein and Sfiri, 2010; & Wright, 2010). In a study of eight secondary teacher education students who used Twitter during their seven week practicum, Wright (2010) discovered these students experienced a sense of community due to the use of Twitter. In particular, Wright found that these pre-service education students appreciated reading the tweets of their peers as well as receiving messages of support when they faced difficult situations during their practicum experience. An added benefit to being a part of this community, Wright noted, was that students became increasingly reflective about their practice; they started thinking about not only what they were doing in the classroom but *why* and *how* they were doing it. These results could be attributed to the fact that only eight participants were included in this study, thus allowing for a sense of community and connections to be formed. In addition, students were given specific prompts to respond to such as "What am I doing now?", "What do my students say about their learning?", and "What am I going to do next?" that is unlike the majority of other studies in which instructors provided no direction about the content of the tweets.

Pauschenwein and Sfiri (2010) and Domizi (2013) found similar results in their studies. Pauschenwein and Sfiri (2010) examined the motivation of educators for learning by using microblogging while they were enrolled in online training courses. These educators included professors from universities in Germany and Australia as well as company coaches and school teachers. Pauschenwein and Sfiri found that educators formed social bonds by using Twitter to discuss course content and engage in informal conversations. In a related study of 16 graduate students in a 16 week seminar course on pedagogy and course design, Domizi (2013) discovered that students felt more connected to each other and got to know each other because of the use of Twitter. Additionally, Domizi found students reported that a sense of community made them feel more comfortable participating in conversations, sharing resources, and describing their own classroom experiences. One student stated, "I had completely incorrect ideas about what Twitter is." (p. 49). The student added, "It is a great way to have quick discussions to present ideas, thoughts, and opinions" (p. 49). These students were given detailed directions about how to use Twitter, which could account for the fact that students experienced a sense of community in the classroom.

In summary, results from these studies demonstrate that Twitter helps to build classroom community. Students often form social bonds during informal exchanges and support each other during the learning process by answering tweets and posting messages of encouragement. These results could be attributed to the fact that students in some classes are more social in nature than students in other classes. Class size could be another factor because students in large classes may not feel as connected to each other as

students in smaller classes. As mentioned previously, the nature of the course could also account for the degree of community building in the classroom. Students enrolled in courses that include more facts than opinions, such as a mathematics or biology course, may not feel a sense of community as compared to students enrolled in a geography or history class where more opportunities to engage in discussions exist, resulting in the formation of relationships and a sense of community.

Twitter as a Learning Tool

The research literature also establishes a link between the integration of Twitter in the classroom and learning outcomes. Researchers have found that the integration of Twitter assists students in learning course concepts and gaining knowledge in various subject areas (Blessing et al., 2012; Junco et al., 2010; Junco et al., 2012; Prestridge, 2014; Tanner et al., 2013, & Yakin and Tinmaz, 2013). Junco et al. (2010) examined the effects of Twitter on student learning outcomes by comparing students' grades between the experimental group that used Twitter and Ning and the control group that only used Ning. Junco et al. found that the grades of the experimental group were significantly higher than the control group. In a follow up study, Junco et al. (2012) found similar results. Using a similar setting of 118 students enrolled in a pre-health professional seminar course, Junco et al. discovered that semester grades of the experimental group that used Twitter were significantly higher than the grades of the control group that used Ning. However, other explanations for the outcome of this study should also be considered. First, the use of Twitter could have resulted in instructors taking a more active role in teaching and learning. Because Twitter lends itself to having discussions

whereas Ning is a static bulletin board, Junco et al. contended that Twitter allows students and the instructor to interact on a regular basis. Second, Junco et al. conducted this study with 125 students enrolled at an American university, which might not be representative of all higher education institutions, nationally and internationally. In addition, Junco et al. conducted this study with undergraduate students who were pre-health professional majors, which do not reflect the findings of students who are enrolled in other subject disciplines. Therefore, future studies are needed to determine other factors that may have influenced student grades, such as the integration of Twitter into a wide range of disciplines (e.g., mathematics and science), in various universities, and using a variety of class sizes.

In related studies about Twitter as a learning tool, Blessing et al. (2012) and Tanner et al. (2013) found that the use of Twitter in class improved student learning as evidenced by their test scores. In a study of 63 undergraduate students in an introductory psychology course at the University of Tampa, Blessing et al. (2012) concluded that students in the experimental group who received psychology-related tweets performed significantly better on the five examinations given throughout the semester than the control group who received humor-related tweets not pertaining to psychology. Tanner et al. (2013) also determined that integrating Twitter into a college algebra course improved test scores. When students encountered difficulties in learning, Tanner et al. reported that students composed a tweet and included a picture in an attempt to show how they were solving the problem. The instructor responded with suggestions and strategies, which helped students to use individualized feedback to understand algebraic concepts.

Additionally, due to the social nature of Twitter, Tanner et al. noted that other students responded to questions from their peers about an algebra problem, which changed the dynamics of the classroom because it allowed each student in the classroom to be a teacher by tutoring their classmates. As a result, Tanner et al. noted, these students achieved higher grades in all three examinations compared to the same algebra classes, which were taught using traditional methods. An added finding in this study relates to the student drop-out rate for instructors who incorporated Twitter into algebra classes compared to instructors who did not use Twitter. Tanner et al. found that the withdrawal-failure- D- grade (WFD) rate decreased to 9% in the Twitter algebra class and there was an 80% improvement in the WFD rate over the non-Twitter algebra classes taught in 2010 and a 72% improvement in the WFD rate over the non-Twitter sections taught in 2012.

In other studies about Twitter as a learning tool, Prestridge (2014) and Yakin and Tinmaz (2013) discovered that Twitter helped instructors and students to meet general learning outcomes. Prestridge (2014) conducted a study with participants from a new bachelor of education program and found the majority of students believed that paraphrasing using Twitter helped them to learn course content and to build metacognitive skills as they converted information into knowledge. Additionally, as the course progressed, Prestridge found that students started to apply their knowledge by tweeting examples, pictures, links, and other visuals, which signified that active learning had occurred. In a related study, Yakin and Tinmaz (2013) required students in a computer applications course to complete a survey three times throughout the course and

they also found that students increased their use of Twitter for learning purposes. Yakin and Tinmaz also noticed that students' ideas for using Twitter evolved as the course progressed. In particular, Yakin and Tinmaz found a considerable increase in the number of retweets and direct messages. Furthermore, as students used Twitter more, they gained more followers and the more they followed others, perhaps because as students became adept at using Twitter and conveying their knowledge and opinions, the more other people decided to follow them. Additionally, because students started to follow other Twitter users, Yakin and Tinmaz found that student learning increased due to sharing and knowledge creation. However, the instructor in this study gave an introduction to Twitter use at the start of the course unlike the instructor in the study that Prestridge conducted. Additionally, in Prestridge's study, students rarely retweeted or answered questions that classmates posted on Twitter, which could be attributed to the large class size and the fact that training about how to use Twitter was not provided, because as assumption was made that students already possessed this knowledge.

In another study about Twitter and student learning, Kassens-Noor (2012) conducted a one month study with 15 students in a first year university level urban planning class. One of the objectives of the course was to identify unsustainable practices in cities and to generate possible solutions. One group used Twitter to share and exchange ideas while the second group used a journal to track their thoughts followed by a group discussion near the end of the course. Kassens-Noor found that the group that used Twitter identified more unsustainable practices and generated more solutions for each unsustainable practice than the journal group; however, the journal group performed

better on the end-of-the-course test than the Twitter group. These results indicate that Twitter was helpful in knowledge creation but not in knowledge retention. This finding could be explained by the fact that Twitter facilitates the sharing of ideas beyond the classroom, which helps students to construct knowledge but does not support knowledge retention due to Twitter's 140 character limit, which Kassens-Noor concluded may prevent self-reflection and critical thinking. The results from this study contradict Junco et al.'s (2010, 2011) conclusion that the use of Twitter increases academic achievement. Kassen-Noor's findings could be explained by the fact that the journal group had the opportunity to share their knowledge before they wrote the test, whereas the Twitter group did not have the chance to meet as a group or re-read their Twitter feed.

In summary, the majority of these studies demonstrate that Twitter can enhance learning in the classroom. Studies that researchers conducted in classrooms in various disciplines or subjects reveal that integrating Twitter into the classroom for instructional purposes can increase test scores as well as impact student perceptions about the value of using Twitter to meet course objectives. Because students respond to each other's questions on Twitter, they often assume the role of a teacher, helping classmates to understand the course material. However, some studies revealed that students do not actively participate on Twitter for learning purposes. These results could be attributed to the lack of teacher direction about how to use Twitter to enhance learning, the large number of students in a class, and minimal teacher participation on Twitter to assist students in answering questions and meeting course objectives.

Twitter as a Tool to Learn a Foreign Language

Even though no studies were found in this literature review that were related to using Twitter to improve student learning in mathematics, I did find studies indicating that Twitter is a valuable tool for students who are learning a foreign language. The research literature reveals that learners from a variety of educational settings find Twitter to be an effective tool for learning about language, customs, and traditions (Antenos-Conforti, 2009; Borau et al., 2009; Faizi et al., 2014; Laretta-Azelain, 2013; Lomicka & Lord, 2013; Vazquez-Cano, 2012). In one of the first studies conducted in relation to second language acquisition, Antenos-Conforti (2009) incorporated Twitter in an intermediate university level Italian course to gain students' insight into the benefits of using Twitter to learn about language and culture. Through surveys and questionnaires, Antenos-Conforti discovered that the majority of students believed that Twitter increased their confidence in writing in Italian. Furthermore, Antenos-Conforti found that the use of Twitter allowed students to expand their vocabulary through negotiated meaning and to receive feedback from the teacher to improve their language skills. The results of this study could be attributed to a number of factors. The course consisted of 22 students, which allowed for increased interaction between students who wanted to practice their Italian language acquisition skills. The course syllabus provided instructions about how to create a Twitter account, and the instructor of the course brought students to the computer laboratory to ensure that every student created a Twitter account and added their classmates as followers. Furthermore, students were required to tweet three times a week, which included two personal tweets and one tweet in the form of a response to a

classmate. As students became more comfortable using Twitter, Antenos-Conforti found that students began to tweet more frequently about personal matters such as entertainment preferences, their hobbies, and their families. An interesting result was that individuals who were not a member of the classroom community started to follow the class and proceeded to ask questions about Manhattan after reading tweets from students who had visited Manhattan. The findings of this study, therefore, demonstrate that a social media platform like Twitter can be used for educational purposes. However, Antenos-Conforti did not investigate Twitter as a tool to assess grammatical and cultural knowledge through the use of pre- and post-tests, and therefore, further studies should focus on acquiring measurable results to assess the usefulness of Twitter in a foreign language classroom.

Lomicka and Lord (2012) conducted a similar study with 13 students in an intermediate level French course at a university in the southeastern region of the United States. Over the course of 9 weeks, Lomicka and Lord noted that students tweeted among themselves as well as with 12 native French speakers in France. Lomicka and Lord found that end-of-semester surveys indicated that the majority of students found Twitter to be effective in learning the French language as well as the culture, even though the native speakers from France participated minimally. Results also indicated that students were comfortable tweeting in French because they knew their classmates, which indicates the importance of classroom community and social presence in the classroom. Lomicka and Lord also found that students were able to infer the meanings of tweets they were unsure of due to the context of the tweets. These results could also be attributed to the novelty of

using Twitter in the classroom and a small sample size of 13 students, which also could have contributed to increased student interactions using this social media tool. Furthermore, Lomicka and Lord found that students did not take advantage of several features of Twitter including retweeting and direct messages, even though these features were mentioned in the course. This finding demonstrates that teachers need to provide more explicit instruction about the variety of features offered by Twitter. Finally, students reported that they would continue to use Twitter after course completion for learning purposes rather than social purposes, indicating that Twitter does have value in learning course content.

In a study of native Spanish speakers enrolled in an online introductory level German language course, Castrillo de Laretta-Azelain (2013) concluded that 72.2% of students believed that using Twitter helped to improve their written skills in German, specifically in the form of expository writing. These native Spanish speakers identified the 140 character limit as an advantage because it decreased their anxiety about communicating in German, and as a result, they felt less inhibited about their German writing skills. Students also reported that they would like to continue to use Twitter for learning purposes, as students did in Lomicka and Lord's study. However, students in this study also reported that they were overwhelmed by the number of tweets because the class included 65 students who were tweeting and replying to tweets. This problem could be solved if students were organized in small groups in order to communicate in the target language and learn from each other. Additionally, this study only examined expository writing, and therefore, Castrillo de Larreta-Azelain recommended that

additional studies need to be conducted to determine if Twitter is successful in helping students to write using other forms such as reports and explanations.

In another foreign language study using social media, Faizi et al. (2014) conducted a survey with 720 students across various disciplines at a university in Morocco and found that 81% of students use social media tools such as Twitter and Facebook to learn another language because they can interact more effectively with peers and colleagues. Faizi et al. found that students identified listening as the main language skill that improved for them. This finding could be due to the fact that social media platforms like Facebook and Twitter allow for links to videos and podcasts to be posted.

Borau, Ullrich, Feng, and Shen (2009) also explored the use of Twitter as a learning tool in a blended classroom environment with 82 students at a Chinese university. They found, through the use of questionnaires, that 70% of students believed Twitter to be a useful tool for developing their English language skills. However, contrary to the findings of Antenos-Conforti's (2009) and Lomicka and Lord (2012), Borau et al. found that Twitter does not help students to develop strategic competence in terms of their ability to effectively resolve communications breakdowns; instead, Borau et al. found that the 140 character limit and the use of a dictionary limited student use of communication strategies when breakdowns occurred. Borau et al. also found that students had difficulty deducing the meanings of tweets when they encountered language problems.

In another foreign language study involving the use of Twitter, Vazquez-Cano (2012) conducted a five month study with 280 high school students and 15 teachers in

Spain. The objective of the study was to determine if Twitter could be integrated into an interdisciplinary program to improve linguistic competence in reading and writing. The three subjects chosen for this study were a Spanish language class, a social sciences class, and a natural sciences class. Data for this multiple-case study were collected over 5 months using interviews, school examinations, and national standardized test results. Pre- and post-test results demonstrated that students who used Twitter improved key reading and writing competencies as identified in the Spanish national assessments when compared to a control group. These results, Vasquez-Cano concluded, demonstrate that Twitter can be an effective tool to improve the reading and writing skills of secondary students in addition to be a helpful resource to encourage collaboration and communication between students and teachers.

In summary, the results from these studies demonstrate that Twitter can be a useful tool in helping students to learn a foreign language. Students not only increased their knowledge of sentence structure and expanded their vocabulary in the target language, but they also learned about the culture and traditions related to the foreign language. Students also recognized the value of using Twitter to learn another language because they expressed their desire to continue using Twitter even after course completion to enhance their vocabulary and grammar skills in the target language. In addition, the use of Twitter has been shown to increase test scores on national assessments in reading and writing in Spain. This study should be replicated in other countries to determine if the use of Twitter increased achievement in reading and writing on national, provincial, and state levels. These studies also indicate the potential of using

Twitter in other subject areas, such as learning mathematical concepts and investigating historical and current events.

Benefits of Using Twitter to Improve Student Learning

The benefits of using Twitter to improve student learning are clearly articulated in the research literature. A social network platform such as Twitter presents many opportunities for engagement and learning. One significant benefit of Twitter is that students develop the ability to communicate with their peers and instructor in both academic and social contexts (Prestridge, 2014; Fox & Varadarajan, 2011; Junco et al., 2011; Yakin & Tinmaz, 2013). Students are able to express opinions (Fox & Varadarajan, 2011), share ideas (Domizi, 2013; Yakin & Tinmaz, 2013), have thoughtful discussions on course topics (McArthur & Bostedo-Conway, 2012) and communicate on a more personal level using Twitter to form social bonds (Dunlap & Lowenthal, 2009; Lin et al., 2013; Prestridge, 2014; Pauschenewein & Sfriri, 2010; Wright, 2010).

In terms of improving student learning, Twitter helps students to retain information (Blessing et al., 2012) and to learn course content (Fox & Varadarajan, 2011; Tanner et al., 2013). Twitter use allows learners to link theory, content, and experiences because they are able to connect with other students (Kassens-Noor, 2012). Twitter encourages instructors to support student debates that occur in real-time in the classroom because the Twitter feed can be projected on a screen at the front of the room (Andrade et al., 2012 Elavsky et al., 2011; Yakin & Tinmaz, 2013). Furthermore, Twitter allows students to tweet questions when they encounter difficulties as well as to post links to videos and additional articles in order to understand the content more deeply (Welch,

2012). In addition, some students have expressed enthusiasm for being able to connect with professionals outside the classroom in order to understand current issues related to their field of study (Lowe & Laffey, 2011). In terms of learning another language, Twitter helps students to improve their writing skills (Antenos-Conforti, 2009; Borau et al., 2009; Lomicka & Lord, 2012; Laretta-Azelain, 2013; Vazquez-Cano, 2012) as well to communicate with native speakers of the target language (Borau et al., 2009).

The fundamental features of Twitter are also highlighted as advantageous to student learning. The ability to use hashtags to categorize tweets (Lowe & Laffey, 2001; Fox & Varadarajan, 2011), to post links to videos and images (Lowe & Laffey, 2011), and to send direct messages (Dunlap & Lowenthal, 2009; Ebner, 2010) are all considered beneficial components of Twitter in relation to student learning. The 140-character limit on Twitter is emphasized as another key element that promotes learning because students need to assimilate information in a short succinct message, which improves critical writing skills (Lowe & Laffey, 2011; McArthur & Bostedo-Conway, 2012; Prestridge, 2014; Wright, 2010). Furthermore, Twitter is convenient because it can be accessed anywhere, anytime using a mobile device (Lowe & Laffey, 2011), and it has privacy settings, which means that tweets are only visible to followers of that individual (Rinaldo et al., 2011). Twitter allows users to communicate with many individuals at the same time because tweets can be seen by all followers of that person, which enhances engagement (McArthur & Bostedo-Conway, 2012; Rinaldo et al., 2011).

Challenges of Using Twitter to Improve Student Learning

Several challenges to using Twitter in the classroom were revealed in the literature review. The 140 character limit, although considered an advantage can also be viewed as a drawback because students are not able to express their thoughts and opinions in such a short message, which can result in poor writing habits (Lowe & Laffey, 2011). Grosseck and Holotescu (2008) also noted that the 140 character limit on Twitter can promote the use of improper grammar.

Additionally, students in large classes can produce a voluminous number of tweets, overwhelming students and causing them not to respond (Fox & Varadarajan, 2011; Lowe & Laffey, 2011). For example, even though students tweeted intelligent questions in a pharmacy course, they were overwhelmed by the large number of tweets, which resulted in their ability to answer very few questions on Twitter (Fox & Varadarajan, 2011). Lowe and Laffey (2011) also attributed the lack of interactivity between students on Twitter to the class size of the course.

The use of Twitter can also cause students to tweet inappropriate information and opinions, which are not related to the course. In a study about using Twitter in a marketing course, Lowe and Laffey (2011) stated that some tweets composed by students were of a personal nature and were not relevant for learning about marketing concepts and current issues related to marketing. In a study about the use of Twitter to encourage interaction in a multi-campus pharmacy management course, when students decided to retweet a message, Fox and Varadarajan (2011) contended that students could edit the

tweet using unsuitable content, causing embarrassment and possible harm to the original tweeter.

Twitter can also be a distraction in the classroom because, as Fox and Varadarajan (2011) found in their research about Twitter use in a pharmacy course, it prevents students from taking notes and listening to the instructor. In a discussion about using Twitter as a pedagogical tool, Rinaldo et al. (2011) also noted that students using Twitter for educational purposes can become unfocused and begin to tweet for social purposes, distracting them from the learning occurring in the classroom.

The issue of accessibility is also a challenge. In a study about using Twitter as a learning tool, Rinaldo et al. (2011) found that not everyone can afford a computer or a mobile device. Even for those students who do have these devices, not all of them can purchase a phone plan or an Internet package that allows them constant access to such technology tools. In another study about using Twitter to enhance social presence, Dunlap and Lowenthal (2009) considered the fact that even though Twitter use is free, if the computer is connected to the Internet, students might be charged additional fees if they want to access Twitter from their mobile device. In addition, Welch (2012), who explored student engagement using Twitter in a university classroom, stated that not every student owns a smartphone, which makes the use of mobile devices difficult in the classroom.

Privacy is also a concern. In a case study of Twitter use, Lin et al. (2013) considered the need for students to create a separate Twitter account for academic purposes, which would ensure that students are not following each other on their personal

Twitter accounts. As a result, Lin et al. contended that students would feel protected and safe because classmates and the instructor would not be able to view details of their private lives. Rinaldo et al. (2011) discussed the need for teachers to maintain a sense of safety when they require students to engage in an online platform like Twitter.

In summary, several disadvantages exist when attempting to integrate Twitter into a classroom instruction to improve student learning. Twitter's 140 character limit can promote poor writing habits, which includes incorrect grammar and spelling. The large number of tweets composed can be overwhelming for students to read. Students may also use Twitter inappropriately by composing tweets, which are distasteful and abusive. Additionally, Twitter can be a distracting tool in the classroom because students can use Twitter for social interactions instead of learning purposes. Equity is also an issue because not every student has a laptop computer or a mobile device from which they can access Twitter.

Summary and Conclusions

This chapter included a comprehensive review of the literature related to the use of Twitter in educational settings. The introduction included a restatement of the relevance of the problem and the purpose of this study, followed by the strategies used to conduct the literature review and an explanation of social presence theory as the conceptual framework for this study. Current research was analyzed in relation to Twitter as a communication tool, as an engagement tool, as a classroom community building tool, and as a tool to improve student learning in higher education institutions and elementary and secondary school classrooms. In addition, an analysis of current research related to

the benefits and challenges of incorporating Twitter into classroom instruction to improve student learning was included. This chapter concluded with an analysis of the range of methods that researchers used to conduct studies in this review related to the use of Twitter in educational setting.

Several themes emerged from this literature review. One theme was that Twitter is used as an effective communication tool in classroom instruction. Dunlap and Lowenthal (2009) found that when the teacher encouraged students in an online instructional design and technology course to use Twitter as part of their classroom experience, students in both classes were able to engage in collaboration, information sharing, brainstorming, and problem solving. McArthur and Bostedo-Conway (2012) implied that students who are active on Twitter and follow their instructor may perceive their instructor to be more knowledgeable, approachable, and interactive than they would otherwise, indicating that Twitter may be a promising option for enhancing instructor-student relationships and communication between them. In addition, Andrade et al. (2012) found that students participated in cognitive communication when Twitter was integrated into a Power Point presentation during a lecture because students were involved in commenting, questioning, and debating the concepts that the instructor presented.

A second theme was that Twitter is used as an engagement tool to enhance learning and improve student satisfaction with the course. Elavsky et al. (2011) explored the use of Twitter during one semester of a university course on the role of media in a democracy and found that the majority of students found Twitter increased their

engagement within the course. In a study of Twitter integration in a design and technology course, Dunlap and Lowenthal, found that students continued to engage with each after the course ended by communicating through Twitter. Evans (2014) investigated the role of Twitter in an undergraduate business and management class and found that the more students used Twitter, the more engaged they felt and they were more likely to participate in university related activities, plan social events, and share personal information with others because of their use of Twitter. In addition, Junco et al. also found that Twitter increased engagement because students independently organized study groups and contributed ideas related to arranging extracurricular activities.

A third theme was that Twitter is used to build classroom community by creating personal and professional connections. In a study of secondary teachers who used Twitter during their teaching practicum, Wright (2010) discovered that these pre-service education students appreciated reading the tweets of their peers as well as receiving messages of support when they faced difficult situations during their practicum experience. Pauschenwein and Sfiri (2010) examined the motivation for learning of educators from universities, business organizations, and school teachers by using Twitter while enrolled in online training courses and found that these educators formed social bonds due to this microblogging tool because they discussed course content and engaged in informal conversations. Domizi (2013) discovered that students enrolled in a graduate level course on pedagogy and course design reported that a sense of community formed by participating regularly on Twitter made them feel more comfortable participating in conversations, sharing resources, and describing their own classroom experiences.

A fourth theme was that teachers use Twitter to help students to meet course learning objectives. Junco et al. (2010) examined the effects of Twitter on student learning outcomes by comparing students' grades between the experimental group that used Twitter and Ning and the control group that only used Ning. Junco et al. found that the experimental group had better grade point averages at the end of the semester than the control group. In a study of students enrolled in an introductory psychology course, Blessing et al. (2012) concluded that students in the experimental group who received psychology-related tweets performed significantly better on examinations given throughout the semester than the control group who received humor-related tweets not pertaining to psychology. In addition, Tanner et al. (2013) also found that the test scores of students enrolled in a college algebra class improved compared to the same algebra classes that did not incorporate Twitter into their classroom for learning purposes.

Using Twitter to learn a foreign language also emerged as a fifth theme. Antenos-Conforti (2009), in a study of Twitter use in an intermediate university level Italian course found that the majority of students believed that Twitter increased their confidence in writing in Italian and helped to expand their vocabulary. Castrillo de Laretta-Azelain (2013) concluded that native Spanish speaking students believed the use of Twitter assisted them to improve their written skills in German. These students also reported that they would like to continue to use Twitter to learn the target language. In a study that included students enrolled in an intermediate level French course, Lomicka and Lord (2012) found that the majority of students found Twitter to be effective in learning the

French language as well the culture. Students expressed their comfort level in tweeting in French because they built relationships with their classmates due to the use of Twitter.

A review of the research literature also revealed several research gaps. One of these gaps is the relatively unexplored area of how teachers use social media tools for instructional purposes to improve student learning in elementary and secondary classroom settings. Another research gap involves investigating how teachers and students may overcome the challenges in using Twitter in order to discover its full potential for learning. A third research gap is that limited empirical evidence exists in how teachers can use Twitter to assess grammar, vocabulary, and sentence structure in helping students learn to compose high quality tweets. In addition, studies need to be conducted about the factors that enhance or inhibit the success of Twitter as a tool to improve student learning.

Chapter 3 includes a detailed description of the research method that was used for this study. This chapter includes the research design and rationale, role of the researcher, research sample and population, data collection tools, data collection and data analysis procedures, issues of trustworthiness, and ethical considerations.

Chapter 3: Research Method

The purpose of this qualitative case study was to explore how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit. To accomplish that purpose, I described how a teacher uses Twitter to help students improve their learning in mathematics. I also described how a teacher and students perceive the value of using Twitter to improve learning in mathematics. Finally, I explored how documents and artifacts such as tweets and problem solving notebooks supported student learning in mathematics.

This chapter outlines the research method I used to conduct this study, and includes a definition of case study design and the rationale for choosing this design. In relation to the methodology of this study, I discuss my role as researcher, participant selection criteria, data collection instruments, recruitment procedures, and data collection process, and present the data analysis plan. I conclude by discussing issues related to the trustworthiness and ethical procedures I used to conduct this study.

Research Design and Rationale

In this study, I used a case study design grounded in the qualitative tradition. Qualitative research is often suggested for research studies that are exploratory or descriptive in nature. Merriam (2009) described qualitative research as an approach for studying the experiences of people and the meaning of those experiences. Creswell (2007) stated that qualitative research is appropriate when the phenomenon is new and needs to be investigated in order to gain a deeper understanding of the phenomenon. Unlike quantitative researchers who use a reliable and valid instrument to measure causal

relationships, qualitative researchers conduct in-depth interviews and make observations in the participants' natural setting (Johnson & Christensen, 2012). The purpose of qualitative research is to describe or explain a phenomenon by providing rich description using words and visuals rather than numbers and statistics (Merriam, 2009; Yin, 2009). The purpose of this study was to describe how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit. This study was needed because the use of social media to improve student engagement and learning is an emerging phenomenon that warrants further examination. This qualitative study contributes to an understanding of how teachers integrate social media tools such as Twitter into classroom instruction in order to enhance learning. The literature review also revealed that researchers have employed qualitative, quantitative, and mixed methods designs when exploring the use of Twitter in higher education institutions; however, very few qualitative studies exist about the use of Twitter in elementary and secondary education.

Within the qualitative tradition, researchers can select from several designs such as narrative inquiry, ethnography, phenomenology, grounded theory, and case study. The selection of a qualitative research design depends on the purpose of the research. If researchers want to describe the stories of one or more individuals, they would choose a narrative research design (Creswell, 2007). However, the purpose of this study was not to describe the stories of individuals in relation to their Twitter use. On the other hand, if researchers want to study cultural groups over a long period of time, they would select an ethnographic design (Creswell, 2007). For this study, it was not my intent to describe a

specific cultural group in relation to their use of Twitter. Phenomenology is used when researchers want to describe the lived experiences of individuals in relation to a specific phenomenon (Creswell, 2007). However, the purpose of this study was not to describe the lived experiences of teachers and students in relation to their Twitter use in the classroom. If researchers want to generate a theory based on the data collected from the field, they would choose a grounded theory research design (Creswell, 2007), but my intent was not to generate a theory about social media use in the classroom. The purpose of this qualitative case study was to explore how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit.

To accomplish the purpose of this study, I selected an embedded single case study design. Creswell (2007) defined case study as a research design that involves "an issue explored through one or more cases within a bounded system" (p. 73). Merriam (2009) noted that case study design involves collecting data from multiple sources including interviews, surveys, questionnaires, documents, excerpts from videotapes, and electronic communication. Yin (2014) defined case study design as "an empirical inquiry that investigates a contemporary phenomenon (the case) in depth and within a real-world context, especially when the boundaries between phenomenon and the context may not be clearly evident" (p. 16). For this study, the case was a Grade 8 mathematics course, and the embedded unit of analysis within the case was an instructional unit on data management. Case study was particularly appropriate for this study because the boundaries between the phenomenon of Twitter use in this instructional unit and the

context of instruction in this unit were not clear. Yin (2014) also noted that a case study inquiry

> copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result, relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result, benefits from the prior development of theoretical propositions to guide data collection and analysis (p. 17).

Using this definition, I selected a case study design because I planned to collect data from multiple sources of evidence to provide a rich picture of how a teacher and students used Twitter in a Grade 8 mathematics instructional unit to improve engagement and learning.

I developed the following research questions based on the tenets of case study design.

Central Research Question

How does social presence on Twitter impact student engagement and learning when a mathematics teacher integrates this social media tool into mathematics instruction?

Related Research Questions

1. How does a teacher use Twitter to help students improve their learning in mathematics?
2. How does a teacher perceive the value of students using Twitter to improve their learning in mathematics?
3. How do the students perceive the value of using Twitter to improve their learning in mathematics?

4. How do documents and artifacts such as tweets and problem solving notebooks support student learning in mathematics?

Role of the Researcher

As a single researcher for this case study, my main roles included data collection, data analysis, and data interpretation. I assumed the role of an active listener while I conducted the student and teacher interviews, ensuring that participants did most of the talking in order to obtain rich responses and to reduce the potential for researcher bias. I was also aware of any potential biases I might bring to my analysis and interpretation of the data. Merriam (2009) maintained that because the researcher in a qualitative study is the main instrument for data collection and analysis, he or she must be aware of individual beliefs that might bring potential bias to the study. Researcher bias, Johnson and Christensen (2012) suggested, occurs when researchers want to achieve results consistent with what they want to find out. Therefore, researchers can be selective in recording and analyzing data from interviews and documents in order to align the results with what they want to see. To avoid researcher bias, I used the strategy of data triangulation by comparing and contrasting multiple data sources and the strategy of reflexivity, which is "the process of reflecting critically on the self as researcher" (Johnson & Christensen, 2012, p. 219). Lastly, I assumed the role of transcriber, because I transcribed, verbatim, student and teacher responses to the interview questions. I describe these strategies and others in more detail later in this chapter.

This research study was conducted in a Canadian school district. I have been an educator for 15 years, and I have taught students in Grades 1-8. During the last six years,

I taught students in Grades 7 and 8, and I was recently hired as an instructional coach for a school district. My responsibilities include working collaboratively with classroom teachers to support student learning by focusing on individual and group professional development and by providing instructional support for teachers to increase engagement and achievement in literacy and numeracy.

Participant Selection

The participants in this study included the classroom teacher and six students in a Grade 8 mathematics course in a suburban school district located in a Canadian province. I identified potential teacher participants according to the following inclusion criteria: (a) participant must be employed as a teacher at the research site, (b) participant must be certified as a mathematics teacher at the middle school level, (c) participant must provide instruction for students who are enrolled in the Grade 8 mathematics course at the site, and (d) participant must currently be using Twitter in the Grade 8 mathematics classroom. I identified potential student participants according to the following inclusion criteria: (a) participants must be 13 years old because the rules and regulations for Twitter require that individuals who want to create a Twitter account must be 13 or older, (b) participants must be enrolled in the Grade 8 mathematics course during the time of the study, (c) participants must be able to obtain parental consent to participate in this study, and (d) participants must currently be using Twitter in their Grade 8 mathematics classroom.

From this list of potential participants, I selected the first classroom teacher who returned the consent form to me, indicating an interest in participating in this study. I sent

an invitational letter to all students and their parents in the designated Grade 8 mathematics course, and I selected those students whose parents were the first six individuals to return consent and assent forms giving permission for their children to participate in this study. This sample size was justified because the goal of qualitative research is to provide a rich description of the phenomenon (Merriam, 2009). Furthermore, the goal of qualitative researchers is to generalize to the theoretical propositions and not to the populations (Yin, 2014).

Instrumentation

Yin (2009) identified six possible sources for data collection in a case study including interviews, direct observations, artifacts, documents, archival records, and participant-observation. Case study researchers use as many data sources as possible in order to confirm the findings of the study. Stake (1995) stated that the data collection tools selected in a case study should reflect the purpose of the research and the research questions. Therefore, I designed two instruments for this study, which were an oral questionnaire for the interviews and a written questionnaire for the reflection journals. To establish the content validity of these instruments, I also asked an expert panel of several colleagues with advanced degrees in education to review these instruments for their alignment with the research questions for this study before I collected data. Social presence theory informed the design of the interview questions and the reflective journal questions. According to Rourke et al. (2001), social presence consists of three categories: (a) affective, (b) interactive, and (c) cohesive. Affective factors are related to emotional behaviors (e.g., sharing of personal information, using humor), interactive factors consist

of levels of interactivity (e.g. continuing a discussion thread), and cohesive factors are related to social behaviors (e.g., addressing participants by name, use of personal pronouns such as "us" and "we"; Rourke et al., 2001).

Oral Questionnaire

The design of the oral questionnaire that I used to conduct the teacher and student interviews was based on Merriam's (2009) guidelines for conducting effective interviews. Merriam defined an interview as a "person-to-person encounter in which the interviewer elicits information from another" (p.88). Interviews with the Grade 8 mathematics teacher and six students in this classroom, therefore, provided a rich description of how social presence on Twitter enhances the learning process for solving word problems. For these interviews, I used a semi-structured format, which consisted of asking open-ended questions in order to answer the research questions. Semi-structured interviews are also known as focused interviews, in which the interview may take on a conversational format; however, the interview is still guided by a set of questions that are pre-determined by the interviewer (Yin, 2014). Therefore, I created an interview protocol with open-ended questions that reflected the research questions (Appendix H).

The student interview questions addressed the following topics: (a) students' experiences and opinions in using Twitter to help them understand data management concepts and skills, (b) how students work with their classmates on Twitter to learn about data management concepts and skills, (c) how students believe their role as learners has changed due to their use of Twitter to learn data management concepts and skills, (d) the benefits students believe they receive when using Twitter to learn data management

concepts and skills, (e) the challenges students identify when they use Twitter to learn mathematical concepts, and (f) suggestions on how Twitter can be used by students and teachers to learn other mathematical concepts (Appendix H). I have also aligned these interview questions with the research questions (See Appendix J).

The teacher interview questions address the following topics: (a) the teacher's experiences and opinions in using Twitter to engage students in learning data management concepts and skills, (b) how the teacher believes his/her role has changed due to using Twitter in the mathematics classroom, (c) the benefits the teacher believes students receive when they use Twitter to learn data management concepts and skills, (d) the challenges the teacher believes students face when using Twitter to learn data management concepts and skills, and (e) suggestions about how to engage students on Twitter to enhance their learning of mathematical concepts (Appendix H).

During these interviews, I also used probing questions when needed. Merriam (2009) outlined three types of probing questions: (a) asking for more detail, (b) seeking clarification, and (c) asking for examples. I used probing questions such as, "Can you tell me more about that?", "What do you mean?", "Can you explain that?", "Can you give me an example?", and "Can you think of another example?"

Written Questionnaire

I also designed the written questionnaire that I used for the reflective journals that I asked students and the teacher to maintain during the instructional unit. The teacher and students were asked to respond to three questions that I created. These questions reflect their experiences on Twitter in terms of supporting their learning about Grade 8 mathematical concepts (Appendix I). The content of the three student questions included (a) a description of the content of their tweets, (b) descriptions of the content of their responses to their classmates' tweets, and (c) reasons why they chose to respond to some classmates and not others. The content of the three teacher questions included (a) frequency of tweets, (b) description of tweets in relation to teaching and learning of mathematical concepts, and (c) observations of student engagement to learn mathematical concepts. I asked the teacher and students to write one paragraph for each question for a total of three paragraphs. I asked students and the teacher to complete one journal entry each week, and I collected them at the end of each week. The use of a written questionnaire allowed me to attain a rich account of teacher and student beliefs about the effectiveness of Twitter in improving their understanding of mathematics because they had an opportunity to reflect on their written responses before they submitted them. I also aligned these three questions with the research questions (see Appendix J).

Procedures for Recruitment, Participation, and Data Collection

In relation to recruitment, the Institutional Review Board (IRB) at Walden University required that I obtain signed consent letters of cooperation from my research partner (Appendix A). Therefore, I obtained permission from the director of the

assessment and accountability department of the school board to conduct this study in this Canadian school district. In addition, I obtained permission from the principal of the middle school to conduct this study (Appendix B). In terms of recruiting potential participants, I met with the principal at the middle school to help me identify teachers of the Grade 8 mathematics course in relation to the inclusion criteria that I developed for teacher participation in this study. The principal provided me with a list of teachers who were using Twitter in their Grade 8 mathematics classroom. I then invited these teachers to participate in this study by explaining the purpose of this study and the procedures for data collection.

Concerning participation, I asked the teacher to sign a consent form, indicating his or her willingness to participate in this study (Appendix D). I selected the first one teacher who returned the consent form, indicating his or her willingness to participate in this study. I sent a letter of invitation to all students in the selected Grade 8 mathematics course. This letter was addressed to the parents of these students and included the purpose of the study, the data collection procedures, and the potential benefits of participation in the study. I enclosed a consent form for parents to sign, signifying their approval for their children to participate in this study (Appendix F) as well as an assent form for students to sign (Appendix G). I included the consent form, the assent form, and a self-addressed stamped envelope so that if students were interested in participating in this study, they could return their signed assent form and their signed parents' consent form in that envelope. Those students who were not granted permission by their parents/guardians to participate in this study were automatically excluded from this study.

The students were selected based on the first six students and their parents who returned consent and assent forms to me.

In relation to data collection, I conducted individual interviews with the teacher and the six students. These interviews were scheduled to be 30 minutes in length, and I conducted each one in an office conference room at the school site to ensure privacy. I recorded the interviews using a tape recorder so that I could transcribe the responses immediately afterwards in a Word document. I also uploaded the audio recording to NVivo, which I downloaded on my password protected personal computer.

In addition to the interview data, I collected data from the reflective journals that students and the teacher maintained, using the online blogging platform *kidblog.org*. During the instructional unit, the teacher and students were required to reflect on how they used Twitter to solve mathematical word problems by writing a paragraph in response to a question. At the end of each week, using my password protected personal computer, I collected the data from these journals by printing a copy of their responses and placing them in each participant's file. I collected these reflection journals once a week for the duration of the study.

In terms of documents and artifacts, I collected documents related to the outcomes for the 4 week instructional unit in the Grade 8 mathematics course at the middle school site. These documents included the standards or outcomes for the specific instructional unit on data management in this Grade 8 mathematics course. I also collected artifacts such as tweets from the six student participants once a week from the class Twitter account and the Twitter website using my password protected personal computer. Grade

8 students used the hashtag #8GMathDM in order to locate their tweets. I uploaded the tweets to NVivo using NVivo's NCapture feature, which transferred the tweets I selected to the NVivo software program. I collected student tweets once a week for the duration of the instructional unit. The other artifact that I collected once a week was the student problem solving notebooks. Students used their notebooks to solve the word problems and make notes regarding: (a) the times they used Twitter to ask for help from a classmate, (b) the times they used Twitter to ask for help from their teacher, (c) the times their tweets included a visual, and (d) which tweets they found helpful in learning mathematical concepts and why. I reminded participants that they had an opportunity to review the tentative findings of this study for their plausibility when I had completed that draft. A summary of the data collection and analysis is displayed in Table 1.

Table 1

Summary of Data Collection Tools

Research Question	Data Source	Data Collection Time Frame	Data Analysis
How does social presence on Twitter impact student engagement and learning when a mathematics teacher integrates this social media tool into mathematics instruction?	Students' reflective journals Students' tweets Students' interviews Teacher's reflective journal Teacher's interview	Weeks 1-4 Weeks 1-4 Weeks 5-8 Weeks 1-4 Weeks 5-8	Coding, categorizing, determining themes, and conducting a content analysis using NVivo
How does a teacher use Twitter to help students improve their learning in mathematics?	Teacher's reflective journal Teacher's interview	Weeks 1-4 Weeks 5-8	Coding, categorizing, determining themes, and conducting a content analysis using NVivo
How does a teacher perceive the value of students using Twitter to improve their learning in mathematics?	Teacher's reflective journal Teacher's interview	Weeks 1-4 Weeks 5-8	Coding, categorizing, determining themes, and conducting a content analysis using NVivo
How do students perceive the value of using Twitter to improve their learning in mathematics?	Students' reflective journals Students' tweets Students' interviews	Weeks 1-4 Weeks 1-4 Weeks 5-8	Coding, categorizing, determining themes, and conducting a content analysis using NVivo
How do documents and artifacts such as tweets support student learning in mathematics?	Students' tweets Unit objectives	Weeks 1-4 Weeks 1-4	Conducting a content analysis using NVivo

Data Analysis Plan

Merriam (2009) explained that the preferred method for analyzing qualitative data is to begin the analysis at the same time as the data collection, which ensures that the researcher is not overwhelmed by the amount of data that needs to be processed at the end of the study. Therefore, I started data analysis as soon as I begin to collect data from the interviews, the student reflective journals, and the documents and artifacts.

For this study, I analyzed data at two levels. At the first level, I coded and categorized data from each data source. I used line-by-line coding that Charmaz (2006) recommended for qualitative research to construct codes from the interview and reflective journal data. I then analyzed this coded data by using the constant comparative method that Merriam (2009) recommended to construct categories, reflecting on similarities and differences in the codes. I used a content analysis for the document and artifact review. Content analysis focused on the frequency of responses and the types of tweets composed. I counted and compared key words and phrases in the content of the tweets. I used NVivo for Windows, which includes the NCapture feature that allows tweets from Twitter to be imported based on key words, phrases, hashtags, and users. For each of the data sources, I presented a summary table of constructed categories.

At the second level, I examined the categorized data across all data sources to determine emerging themes and discrepant data. These themes and discrepancies formed the key findings of this study, which I analyzed in relation to the central and related research questions. I interpreted the findings through the lens of social presence theory. Responses from the interview questions, reflective journal questions, and content of the

tweets were interpreted through the three categories as outlined by Rourke et al. (i.e., affective, interactive, and cohesive).

Issues of Trustworthiness

Merriam (2009) asserted that one of the goals of all researchers is to produce results that are valid and reliable. In qualitative studies, Merriam noted that internal validity is referred to as credibility and external validity is referred to as transferability; reliability is referred to as dependability and objectivity is referred to as conformability. Merriam also recommended that researchers consider using specific strategies relative to these constructs in order to improve the trustworthiness of qualitative research.

Credibility

Credibility, Merriam (2009) maintained, is concerned with ensuring the results of the study are believable. Merriam presented five strategies that a qualitative researcher can use to ensure credibility. The first strategy is triangulation, which involves cross-verification of data from multiple sources. Merriam described four types of triangulation: (a) multiple methods, (b) multiple sources of data, (c) multiple investigators, and (d) multiple theories. The other four strategies that Merriam recommended to increase credibility are member checks, adequate engagement, reflexivity, and peer review. Member checks involve seeking feedback about the preliminary interpretations to ensure that they accurately reflect the participants' views and opinions. Adequate engagement, Merriam noted, refers to spending as much time as possible collecting data in order to obtain as much evidence as possible. According to Merriam, reflexivity refers to the researcher critically reflecting on his or her biases and assumptions that may affect the

outcomes of the study. Peer review is defined by Merriam as the process of having a colleague or mentor examine the methods and findings to determine if the findings are reasonable.

For this study, I used the strategies of triangulation and peer review to improve the credibility of this study. I used triangulation by comparing and contrasting data from multiple data sources, including student and teacher interviews, student and teacher reflective journals, course documents, and student tweets and mathematical notebooks. I also used peer review by asking an educational colleague familiar with the research to review the findings for their plausibility. I also maintained written accounts of this peer-debriefing session as Creswell (2007) recommended.

Transferability

Transferability, Merriam (2009) noted, refers to the degree to which the results of a qualitative study can be transferred to other settings. Merriam outlined two strategies to enhance transferability, which include rich thick descriptions and typicality of sample. Rich thick description refers to a detailed description of the setting, participants, and findings, which includes using quotes from interviews, field notes, and documents (Merriam, 2009). Typicality of sample means the researcher describes how a program, individual, or event is typical compared with others in the same category in order for users to make comparisons with their own situation (Merriam, 2009).

For this study, I used the strategy of rich, thick description by providing a detailed description of the setting, the participants, and the findings with direct quotes from the teacher and students from the interviews and reflective journals. I also used the strategy

of typicality of sample by selecting a Grade 8 mathematics course that is typical of other mathematics courses in the district and the province.

Dependability

Dependability, Merriam (2009) noted, is defined as the extent to which the results of the research study can be replicated. In essence, dependability means whether or not the same results would be achieved if the study was repeated. Merriam suggested four strategies to increase dependability in qualitative research: triangulation, peer examination, clarification of the investigator's position, and an audit trail.

For this study, I used the strategies of triangulation, peer review, and an audit trail. I have explained how I used the strategy of triangulation. I used the strategy of peer review by discussing the results with an educational colleague who is familiar with the research to determine the plausibility of these results. I also used the strategy of an audit trail by maintaining my memos and journals using the NVivo software program, which has these features.

Confirmability

Confirmability refers to the degree by which the results from a qualitative study can be corroborated or confirmed by other individuals (Miles, Huberman, & Saldana, 2014). It is often referred to as the objectivity of a study. Strategies to enhance confirmability include reflexivity and transparency. Reflexivity is the process of self-reflection that the researcher uses to identify potential biases and assumptions that might affect the research study (Johnson & Christensen, 2012; Merriam, 2009). Transparency is

the explicit account of the methods and procedures the researcher uses to conduct the research study (Miles et al, 2014).

For this study, I used the strategies of reflexivity and transparency. I used reflexivity by maintaining a researcher's journal in which I described the decisions that I made during data collection and analysis. In addition, I examined the personal assumptions and biases I have about student use of Twitter in a Grade 8 mathematics course and how I planned to minimize these assumptions and biases. I also used the strategy of transparency by explicitly stating the research methods, sequence, and conclusions of this study (Miles et al., 2014).

Ethical Procedures

Merriam (2009) stated that the extent to which a research study can be considered valid and reliable is dependent upon the ethics of the researcher. Before a study is conducted, Merriam noted, the researcher needs to consider the protection of participants, informed consent procedures, right to privacy, and issues of deception. Johnson and Christensen (2012) contended that cognizance of research ethics helps to ensure readers that investigators are conducting research that is ethically sound.

Therefore, for this study, I first obtained permission from the Institutional Review Board (IRB) at Walden University to conduct this study (05-07-15-0329550). In relation to that process, I obtained approval from school district and middle school personnel to conduct this study. I also explained the purpose and data collection procedures to all potential participants. The ethical treatment of research participants in this study included confidentiality and informed consent. Students were assigned private Twitter accounts, in

which the tweets students compose were only viewed by students in that classroom and their teacher. The reflective journals written by students were kept confidential because these reflections were written in a private blog community viewed only by the mathematics teacher for these students. I also obtained signed consent forms from each student participant and their parents or guardians. The right to withdraw from the study at any time was also communicated to students and their parents. I followed strict protocols for data collection and analysis as presented in this chapter, and I stored all data on a password protected computer. I also used pseudonyms for students, the school, and the school district to protect their identities. All data will be destroyed after five years as required.

Summary

This chapter included a description of the research method that I used to conduct this study. The purpose of this research study was to explore how social presence on Twitter impacts student engagement and learning process when a mathematics teacher integrates this social media tool into an instructional unit. Therefore, I used an embedded single case study design to conduct this study in a Grade 8 mathematics classroom at a middle school located in a suburb of a Canadian province. Using purposeful sampling, I selected one teacher and six students from this Grade 8 mathematics classroom. I collected data from multiple sources, including semi-structured, individual interviews with the teacher and six students, reflective journals maintained by these participants, documents such as instructional unit standards and outcomes, and artifacts such as student tweets and their problem solving notebooks. I coded data and constructed

categories using line-by-line coding recommended by Charmaz (2006) for qualitative research as well as NVivo software. I analyzed the coded and categorized data across all data sources to identify emerging themes and discrepant data in order to form the key findings of this study. I established trustworthiness for this qualitative research by using the strategies of triangulation, reflexivity, member checks, peer review, typicality of sample, and rich thick description.

In Chapter 4, the results of this study are presented. This chapter includes a description of the setting, the participant demographics, how data was collected and analyzed, and how trustworthiness was established. The results are analyzed in relation to the central and related research questions.

Chapter 4: Results

The purpose of this embedded single case study was to explore how social presence on Twitter impacts student engagement and the learning process when a mathematics teacher integrates this social media tool into an instructional unit. To accomplish that purpose, I described how a teacher used Twitter to help students develop their learning in mathematics, how a teacher and her students perceived the value of using Twitter to improve learning in mathematics, and how documents and artifacts such as tweets and problem solving notebooks supported student learning in mathematics. This case study was guided by the following central research question: How does social presence on Twitter impact student engagement and learning when a mathematics teacher integrates this social media tool into mathematics instruction? The related research questions were as follows:

1. How does a teacher use Twitter to help students improve their learning in mathematics?
2. How does a teacher perceive the value of students using Twitter to improve their learning in mathematics?
3. How do the students perceive the value of using Twitter to improve their learning in mathematics?
4. How do documents and artifacts such as tweets and problem solving notebooks support student learning in mathematics?

In this chapter, I present the results of the study. I begin by describing the setting and participant demographics, and the data collection procedures. When describing the

data analysis procedures, I explain how I coded and categorized the interview, reflective journal, and student tweet data, and how I determined the themes and discrepant data. I used a content analysis for the documents, and I present summary tables of constructed categories for all data sources. I also discuss the trustworthiness of this qualitative research, including the strategies that I used to ensure credibility, transferability, dependability, and confirmability. I analyze the results of this study in relation to the central research question and related research questions.

Setting

The site for this embedded single case study was a public middle school located in an east-central province of Canada, which included 250 schools with approximately 154,000 students in 2014-2015. During this year, this middle school served approximately 700 students in Grades 6, 7 and 8. Teachers in this middle school followed the mathematics curricula that the ministry of education for this province mandated. In addition to two report cards each year, achievement in mathematics in this province was reported to parents through a standardized test administered to students in Grade 6. In 2012-2013, 2013-2014, and 2014-2015, Grade 6 students in this middle school scored 57%, 62%, and 66% respectively in relation to scoring at or above the provincial standard, which is considered a Level 3 and Level 4. Teachers also reported to parents about course instruction and student achievement in their courses by conducting parent-teacher interviews in the late fall of each school year.

The case for this study was a Grade 8 mathematics course, which all students in this province were required to complete, and the unit of analysis was one instructional

unit on data management embedded in this course. Data management was one of five strands in this course curriculum. The other strands included (a) number sense and numeration, (b) patterning and algebra, (c) geometry, and (d) measurement. In the data management strand, the following twelve curriculum objectives were included: (a) collecting and organizing primary and secondary data, (b) displaying this data in a variety of ways (e.g., bar, pie, line graphs, scatter plots, and charts), and (c) using a variety of strategies to make convincing arguments about the data (Ministry of Education, Mathematics Curriculum Grades 1-8, 2005). The length of this unit was approximately 4 to 6 weeks.

During the time of this study, I did not experience any organizational conditions that influenced participant responses or that influenced my interpretation of the results.

Participant Demographics

I used a purposeful sampling strategy to select participants for this study in order to obtain the richest data possible. Participants included one Grade 8 mathematics teacher, Ms. Miller (pseudonym), and six Grade 8 mathematics students. Ms Miller had earned a Bachelor of Arts degree with distinction and a Master of Arts degree in education. Ms. Miller had been teaching mathematics for 11 years at this middle school, and had taught Grade 8 mathematics for the past 4 years.

Of the six students who were selected to participate in this study, four students including Simran (pseudonym), Avani (pseudonym), Michelle (pseudonym), and Sophia (pseudonym), were female, and two students, including Raj (pseudonym) and Dylan (pseudonym), were male. In addition, four of these students (Simran, Avani, Sophia, and

Dylan) were English as a second language (ESL) students. These students did not receive additional support in mathematics from the school's ESL teacher; however, Ms. Miller provided differentiated instruction for these ESL students in her mathematics classroom. Differentiation strategies include: (a) giving students extra time to complete their work, (b) using visuals to supplement their learning, (c) asking these students to answer fewer questions than the rest of the class, and (d) allowing students to answer in oral format rather than written format (Ministry of Education, Mathematics Curriculum Grades 1-8, 2005).

Data Collection Procedures

For this study, I collected data from multiple sources, including student and teacher interviews, student and teacher reflective journals, and student and teacher tweets. I conducted the teacher interview in the school conference room in late June, 2015 for 23 minutes. I conducted student interviews over a 2 day period in June, 2015. Each of these interviews took place in the school conference room, and they lasted between 15 and 20 minutes.

Over the course of the 4 week study, I collected teacher and student responses to the online reflection journals once a week on Friday. The teacher and the students completed their weekly reflective journals using kigblog.org; the teacher enrolled me as a guest, and I was only able to view the blogs of the six students who were a part of this study.

I collected documents and artifacts including unit objectives for the data management strand, teacher and student tweets, and student notebooks. I collected the

unit objectives for the data management strand during the first week of June from the province's ministry of education website. I collected teacher and student tweets daily for the duration of the unit by visiting the teacher and student Twitter accounts on the Twitter website (www.twitter.com). Even though students in this class used notebooks on a regular basis for the other mathematics strands, during the data management unit, the teacher focused on collaborative problem solving in which groups of students used chart paper and worksheets to record their answers. Therefore, students did not consistently use notebooks because they worked in groups to solve problems and used Twitter to collaborate and learn with and from each other.

Only one variation occurred in the data collection process. This variation was in relation to the mathematical notebooks because students did not use them consistently during the unit that I examined, and therefore, they did not provide any relevant data that I could use for this study. I did not experience any other unusual circumstances during data collection.

Level I Data Analysis

At the first level, I coded and categorized data from each data source. I used line-by-line coding that Charmaz (2006) recommended for qualitative research to construct codes from the interview and reflective journal data. I then analyzed this coded data by using the constant comparative method that Merriam (2009) recommended to construct categories, reflecting on similarities and differences in the codes. I used a content analysis for the document and artifact review. For each of the data sources, I constructed a summary table of constructed categories.

Teacher Interview

The first interview question asked, “Tell me about your experiences using Twitter to engage students in learning data management concepts and skills?”

Ms. Miller described these experiences in some detail. She expressed her belief that Twitter engaged students by extending their learning, providing them with opportunities to interact with a variety of classmates, and emphasizing the use of multimedia. Ms. Miller stated, "They got to practice some of the concepts we learned in class, and it just . . . extended [these concepts] forward, [because] they continued extending it further online." She also believed that students were more engaged with their classmates because they responded to one another, and some students even engaged in conversations with students that they normally wouldn't interact with in the classroom. Ms. Miller also noted that multimedia engaged students, adding:

> At one point we looked at a video that had to do with bias as well, so that connected to YouTube and that was all linked in, so I think overall that was very engaging. They even found their own videos to post so it really did engage them in a different way than they normally would.

Thus, Ms. Miller believed that students were engaged in their learning through the use of multimedia and interactions with their classmates.

The second interview question asked, “What is your opinion about using Twitter to improve student learning in relation to data management concepts and skills?”

Ms. Miller held strong opinions about how to improve student learning by using Twitter. She believed that Twitter helped her to reach all students, noting:

> We have a lot of ESL students in this class, and a lot of them are really quiet; they don't really like to participate in class. Actually I shouldn't say that they don't like to [participate], but it's more they don't feel comfortable participating or putting up their hand[s] to speak in front of the class, but I actually found that with Twitter, it helped improve the communication and interaction between them and other classmates.

However, Ms. Miller also believed that Twitter positively impacted collaboration in the classroom, adding, "I noticed the collaboration in the class just seemed to improve so they were more willing to work with other people and I just think they felt more comfortable." Ms. Miller also noted the importance of visuals on Twitter to help student learn mathematical concepts. She commented,

> We did a cake lesson, and then we took pictures of the cake, and they were able to share it on Twitter and discuss the concepts. They were able to connect a lot more with what we were doing in class because we were all on Twitter to talk about it afterwards.

As a result, Ms. Miller believed that Twitter impacted learning by giving every student a voice, allowing for increased collaboration, and using visuals to enhance mathematical concepts related to data management.

The third interview question asked, "How do you believe your role as a teacher has changed due to using Twitter in your mathematics classroom?"

Ms. Miller believed that using Twitter increased her motivation to use technology in other subject areas, adding, "I'm more open to using it in different subject strands like

history and geography, and it's made me more open and excited to use different types of tools and technology." She also noted that students took over the role of the teacher.

> ....other kids would jump in and help the other students and answer the question for them so that was really awesome because they just seems so much more independent, and I didn't feel like I had to always respond to them right away because they were like actually teaching each other.

Additionally, Ms. Miller noted how using Twitter helped her improve her assessment practices, particularly for ESL students.

> A few students didn't understand when I posted a question about central tendency [because] they had just forgotten.... they put a question out there and then it helped me go back and review with them....Some of my ESL students seemed to practice their English a lot more on twitter....It actually helped me with my assessment practices.

Therefore, Ms. Miller considered Twitter a valuable tool for improving her instructional and assessment practices and for allowing students to take on the role of the teacher.

The fourth interview question asked, "What benefits do you believe students receive when they use Twitter to learn mathematical concepts and skills?"

Ms. Miller believed using Twitter involved several benefits in learning data management concepts, including increased student engagement and collaboration. Ms. Miller stated,

> They were able to show their learning in different ways....They were still able to take what they were doing in class and their written work and also take pictures of it too or just add videos from YouTube so it was really interesting.

Ms. Miller added, "With the ESL [students], it helped some of them come out of their shell a little bit more so online and not be so concerned with their spelling or how their voice may sound so that was really neat." Ms. Miller also noted, "I also found they could reflect on their learning better, [and] they were able to see where they needed some help." In terms of increased engagement, Ms. Miller noted, "They really seemed to enjoy the open ended questions, that really engaged them, and I think as a tool it is something they might use outside of the classroom." Ms. Miller also believed that Twitter enhanced collaboration, adding, "They asked questions so I think it helped them collaborate and help one another and that was a real big benefit because it almost helped spark up new friendships." Thus, Ms. Miller considered Twitter beneficial in terms of positively impacting student learning, engagement, and collaboration.

The fifth interview question asked, "What challenges do you believe students face in using Twitter to engage to learn mathematical concepts and skills?"

Ms. Miller described in detail how one of her students struggled using Twitter in the math classroom. Ms. Miller identified his learning style and the features of Twitter as barriers to his engagement with this social media tool. Ms. Miller stated,

> He said to me that he found it very distracting using his phone to do math and extending it. He preferred the old method. He preferred paper and pencil and the way he's always kind of been taught because he found it didn't work for him.

Furthermore, Ms. Miller noted that the many features of Twitter impacted his engagement with Twitter. The biggest challenges were the 140 character limit and keeping up with the volume of tweets from the other 25 students. Ms. Miller also noted, "It was hard to keep up with one another and for everyone to be responding back and forth with one another because they'd be online at different times." Consequently, Ms. Miller believed that for some students, their learning styles and the characteristics of Twitter could be challenging.

The sixth interview question asked, "What suggestions do you have about how to engage students on Twitter in order to enhance their learning of mathematical concepts and skills?"

Ms. Miller presented many ideas about how to engage students on Twitter to enhance their learning of mathematical concepts and skills. Ms. Miller stated,

> They really liked daily challenges or weekly challenges [so] if I put a challenge out, a lot of them would just start...trying to solve the challenge and it was almost like a race. You could do [a] Trivia Tuesdays or something [like that], for instance.

In terms of student created activities to engage students, Ms. Miller noted that students are required to create their own problems and challenges. She added, "Even just creating their own YouTube videos would be really cool because they really like making videos and using the technology that they like." Ms. Miller also explained how the features of Twitter can be used to engage students, noting,

> Have them follow an actual mathematician or...if they can search by hashtag, you can have them look up for instance central tendency and have them try and find different examples so there's a whole array of different ways they could be engaged.

Thus, Ms. Miller described several ways to use Twitter with students such as asking students to participate in a variety of tasks in addition to leveraging the features of Twitter to engage students in their learning.

Table 2 includes a summary of the major categories that I constructed for the teacher interview data.

Table 2

Summary of Categories for Teacher Interview Data

Questions	*Categories*
TQ1: Engaging Students	Extending learning
	Interacting with classmates
	Emphasizing multi-media
TQ2: Improving student learning	Differentiating instruction
	Assessing student learning
	Collaborating with classmates
	Emphasizing multi-media

Questions	*Categories*
TQ3: Role of Teacher	Motivating students to use technology
	Improving assessments
	Teaching each other without prompts
TQ4: Benefits to Students	Collaborating with variety of classmates
	Reflecting on their learning
	Improving their participation
	Practicing and extending their learning
TQ5: Challenges for Students	Coping with different learning styles
	Responding to large number of tweets
	Composing tweets in 140 characters
	Tweeting at different times
TQ6: Suggestions for Engaging Students	Participating in math challenges
	Creating multi-media products
	Generating questions
	Interacting with industry professionals
	Researching topics and concepts

Student Interviews

The first interview question asked, "Tell me about your experiences in using Twitter to help you solve word problems in data management?"

Students described these experiences in some detail. They explained that Twitter impacted their learning through interacting and collaborating with their classmates. Raj stated, "You could interact with your friends and...help them out with [the] questions....and [I] got some help too." Michelle added, "It was easy to talk to your classmates online...You can post [work] on Twitter and then get feedback." The students also discussed how Twitter enhanced their learning because of the manner in which their teacher used Twitter. Sophia noted that Ms. Miller posted numerous questions, graphs, and pictures so they had opportunities to practice. Therefore, students reported positive experiences using Twitter to learn math concepts because they were able to help each other by communicating and interacting with one another, receiving feedback from their peers, and practicing data management concepts because of the questions Ms. Miller posted.

The second interview questions asked, "What's your opinion about using Twitter to help you to understand data management concepts and skills?"

Five of the six students expressed positive views about using Twitter in the mathematics classroom. They believed that Twitter enhanced communication and interactions with their classmates in terms of understanding data management concepts and skills. Michelle noted, "There's some people in my class who I barely ever talk to but on Twitter we talked and communicated about new things in math." Simran added, "We

were going back and forth on Twitter with our comments on graphs and other [concepts]." Avani talked about how Ms. Miller helped her to understand data management concepts, noting, "It was good because we got math problems...and I solved them and understood what's bias and what's not bias." Avani added that Ms. Miller asked them to tweet a summary of their learning, which got her thinking. Consequently, students found Twitter beneficial for learning data management concepts. Twitter impacted who they connected with and how they connected, as well as giving them the opportunity to practice mathematical concepts through the many word problems that Ms. Miller posted.

The third interview question asked, "How did you work with your classmates on Twitter to learn about data management concepts and skills?"

Students described several ways in which they worked with their classmates to learn about data management concepts and skills. They described how they collaborated on a project, helped each other with word problems, and communicated with each other to share their learning. Simran stated, "I even communicated with people I don't usually in real life and we talked about how we can make the graph better and how it could be less bias." Raj added, "I showed them some of my work too and compared [it] with theirs." Michelle noted, "We did a group project and on Twitter, when we were at home we could communicate our ideas and still work on the project [because] we had Twitter." Thus, students worked with their classmates to learn data management concepts by collaborating on word problems and a class project and sharing their learning with each other.

The fourth interview question asked, "How do you believe your learning has changed when you used Twitter to learn data management concepts and skills?"

Students believed that using Twitter had a positive impact on their learning of data management concepts and skills. Simran stated, "I can interact with more people more easily now...Before I used to have really...long answers with unnecessary data so now I can make it shorter with just the key points." Avani talked about how her the use of Twitter impacted her understanding of mathematical concepts, adding, "We could communicate about math and data management outside of school...Our teacher asked us questions after we answered the question...[and a few] follow up questions." Michelle added,

> It makes me more open to my classmates so I can talk to them about math so...I can actually collaborate with them and talk to them about it and that helped me to understand data management a lot better.

Thus, students believed that their learning was positively impacted because they could communicate about data management concepts outside of school, they were able to think critically in order to compose a tweet that was clear and concise, and the teacher provided a number of follow up questions that made them think about the concepts.

The fifth interview question asked, "What benefits did you experience in using Twitter to solve word problems related to data management?"

Students described many benefits in using Twitter to solve word problems related to data management. They described the usefulness of visuals to help them understand concepts, the connections that they made with everyone in their class, and the variety of

ways in which word problems could be solved. Sophia explained, "We were posting and exchanging videos...and you can post pictures to help the learning." Simran noted, "I got to talk with new people and agree and disagree with them...If I forgot to mention something, someone else would comment." Avani noted that because of Twitter she had the opportunity to see how other students solved problems. She stated, "You're basically learning about what other people are thinking about and how they solve the problem which could be different from yours and then you're adding your own ideas." Thus, students identified the benefits of using multi-media visuals, being able to connect with everyone in the class, and examining the variety of ways in which their peers solved word problems.

The sixth interview question asked, "What challenges did you experience in using Twitter to help you solve word problems related to data management?"

Students described several challenges in using Twitter to help them solve word problems related to data management. In particular, they identified several factors related to the features of Twitter itself as well as technical problems. Raj noted, "One of the challenges I found was you could only use 140 characters, and I couldn't fit my answer in 140 characters so I had to use more than one tweet to answer a question." Michelle added, "You can't always respond to all of your classmates because of so many tweets happening so you don't want some people to feel left out by not responding to them so I guess that's kind of a downfall." Avani added, "I was completely lost! I got confused about the login...and how to use it." In terms of technical issues, Sophia stated, "My Internet wasn't working the last two days so I couldn't use Twitter but I caught up after."

Thus, students identified the features of Twitter and technical issues as barriers to using Twitter to improve their mathematical learning.

The seventh interview question asked, "What ideas do you have for students about how to use Twitter to help students learn mathematical concepts such as integers, fractions, and algebra?"

Students shared several ideas about how they believed students could use Twitter to help them learn a variety of mathematical concepts. Some of these ideas included the use of multi-media, interacting often with peers, asking questions, and posting often. Raj noted, "Add pictures and upload lots of pictures so you can show your work that way." Michelle noted that asking questions impacts learning, adding,

> When you're using it to learn...when you have an idea, don't be afraid to post it because...everyone learns new things, and even if you post something that's not right, someone can help you correct that, and then it will help you develop further and make you understand it better [because] you don't want to be doing it wrong.
>
> So if you post it and you end up being wrong, then someone can help correct you.

Sophia also noted, "Post tweets more often so that the teacher can know if you understood." Thus, students suggested several ideas that other students could consider in learning mathematical concepts, which included posting questions, using videos and pictures, interacting with peers on a regular basis, and posting often so the teacher could determine students' understanding of concepts.

The eighth interview question asked, "What suggestions or ideas do you have for teachers about how to use Twitter to help students learn mathematical concepts such as integers, fractions, and algebra?"

The students offered a number of suggestions for teachers about how to use Twitter to help students learn a variety of mathematical concepts. These ideas included posting word problems daily, asking follow up questions, adding visuals, and frequently assessing students' understanding of the concepts. Raj stated, "Give questions...daily, which allows students to be involved in the classroom and their learning." Sophia added, "Ms. Miller used videos to help us...so that was really helpful...and then she wrote follow up questions and those were challenging and were fun to do and helped us to think." In terms of assessments, Avani stated, "[Teachers] can post questions and assess students online...giving us feedback on our answers [would] help." Thus, students suggested that teachers post questions daily in the form of word problems and probing questions, post multi-media products such as videos and pictures to enhance learning, and assess students by providing feedback on their work.

Table 3 includes a summary of the major categories that I constructed for the student interview data.

Table 3

Summary of Categories for Student Interview Data

Questions	*Categories*
SQ1: Experiences using Twitter to solve word problems	Interacting with classmates
	Collaborating with classmates
	Receiving feedback
	Practicing concepts
SQ2: Using Twitter to understand data management	Communicating with everyone
	Interacting with peers
	Thinking about their learning
SQ3: Working with classmates on Twitter	Collaborating on word problems & projects
	Helping each other with word problems
	Comparing their work
	Communicating with classmates

Questions	*Categories*
SQ4: Beliefs about changes in learning	Composing concise tweets
	Answering probing questions
	Communicating outside of school
	Practicing and extending learning
SQ5: Benefits from using Twitter	Emphasizing use of multi-media
	Connecting with different classmates
	Examining many ways to solve problems
SQ6: Challenges from using Twitter	Attempting to respond to everyone
	Composing tweets in 140 characters
	Experiencing technical issues
SQ7: Ideas for students	Emphasizing use of multi-media
	Interacting with other students often
	Asking questions
	Posting often

Questions	*Categories*
SQ8: Ideas for teachers	Posting math problems and challenges
	Asking probing questions
	Emphasizing use of multi-media
	Assessing student responses

Teacher Reflective Journals

The first reflective journal question asked, "How frequently did you post tweets? How would you describe the content of those tweets?"

Ms. Miller reported that she posted tweets every day related to the mathematical concepts that she emphasized in the lesson. These posts consisted of word problems, multi-media, and follow up tasks regarding concepts such as bias, central tendency, and different types of graphs. Ms. Miller stated, "I posted everyday, and occasionally on weekends...I posted a video related to bias and asked students to tweet what they learned and find a similar video [to tweet] to discuss bias in graphs." Ms. Miller added, "I also posted numerous visuals of graphs and students had to identify what was wrong with the graphs." Ms. Miller also noted, "The content was usually a follow up activity or extension of what we were doing in class that day." Thus, Ms. Miller described her tweets in relation to posting problem solving questions, using multi-media such as

pictures and videos, and providing extension activities related to the concepts of data management.

The second reflective journal question asked, "How frequently did you engage with students during the instructional unit on data management? How would you describe the nature of these interactions? Were some interactions not related to this unit? If so, how would you categorize the nature of these interactions?"

Ms. Miller described these experiences in some detail. Ms. Miller stated that she engaged with students on a daily basis by answering their questions, asking prompting questions related to their answers to the word problems, and providing feedback to the students. Ms. Miller stated, "I engaged with my students everyday responded with answers to their questions as well as further prompting questions related to data management." She added, "I responded with positive comments and emojis (happy faces, thumbs up) [and] hashtags [#bias, #lookclose, and #showmethatmath]." In terms of interactions not related to the unit, Ms. Miller noted that she posted reminders and announcements on Twitter on a regular basis, adding, "Some tweets were about...posting homework, guest speakers coming in, graduation rehearsal, and quizzes...Some of us were even tweeting about our favorite foods." Thus, Ms. Miller engaged with her students by asking probing questions, responding to their questions, providing feedback, posting reminders and announcements, and interacting with students about their personal preferences such as favorite foods, movies, and TV shows.

The third reflective journal question asked, "How do you believe students were engaged on Twitter to enhance their learning about data management concepts and skills?"

Ms. Miller believed that the students engaged on Twitter in several ways to enhance their learning about data management concepts and skills. Ms. Miller noted that students regularly used emojis and hashtags, shared their learning, interacted with one another, asked questions, taught each other concepts, and found and posted multi-media resources. Ms. Miller also noted, "They started to use many more emojis and started to interact and comment on each other's posts more frequently." Ms. Miller added,

> They were able to answer each other's questions before I did and it also allowed them to work with their group members online. They were very respectful and supportive of one another. They were able to practice and see each other's examples and learn from their perspectives. Students also took pictures of their work and said how math was fun and engaging.

Thus, Ms. Miller believed the students were highly engaged because they interacted with each other, shared their learning, asked questions, and used emojis and hashtags to express their thoughts and feelings.

Table 4 includes a summary of the major categories that I constructed for the teacher reflective journal data.

Table 4

Summary of Categories for Teacher Reflective Journal

Questions	*Categories*
TQ1: Description of tweets	Posting daily word problems
	Adding multi-media
	Creating extension activities
TQ2: Engaging with students	Engaging daily
	Asking probing questions
	Answering student questions
	Providing feedback
TQ3: Student engagement	Using emojis and hashtags
	Interacting in a variety of ways
	Asking questions
	Teaching each other
	Adding multi-media

Student Reflective Journals

The first reflective journal question asked, "Describe the content of your tweets this week."

Students provided detailed descriptions of the content of their tweets for each week, which included answering the word problems Ms. Miller posted, summarizing

their learning, asking questions, posting multi-media resources, and communicating with their peers on topics unrelated to mathematics. Raj stated, "I tweeted about different types of graphs such as bar graphs, pie graphs, scatter plots and histograms. I answered the tweets of my teacher as well as the follow up questions she asked." Sophia noted, "I also asked my classmates questions on twitter to get help from them about the question." Sophia added, "[With] every tweet I [have] been adding hashtags (e.g., #maths or #mathisfun)." In terms of posting multi-media resources, Simran noted, "I also tweeted a link to a video about bias in graphs and a photo of my Simpsons math activity." Some of the tweets also contained content unrelated to mathematics, such as when Dylan noted, "I described my favorite food since Ms Miller posted that fun question." Raj stated, "I described how hard the tests were." Thus, the content of students' tweets included answering the word problems posted by Ms. Miller, reviewing their learning, asking questions, posting multi-media resources, and discussing personal preferences.

The second reflective journal question asked, "Describe the content of your responses to your classmates tweets."

Students engaged in several ways with their classmates on Twitter, which included providing feedback, asking questions, encouraging their peers, interacting on a social level, and using emojis to express feelings and emotions. Simran stated, "I agreed with my classmates' tweets and then shared an idea with them and asked them [what] they thought about it. I also used emojis so they [felt] comfortable answering." Michelle added, "I also encouraged my peers to continue tweeting by complimenting and recognizing their skills." Sophia noted, "I told them thank you for helping and added

those emojis. I also thanked them for showing me videos from YouTube on Twitter so I could understand better." Avani stated, "I also helped to answer classmates questions about what we did in class." Raj added, "I also responded by helping out some of my classmates who were stuck on a question. I gave them hints and clues about them." Thus, students interacted with their classmates on Twitter by asking questions, responding to their difficulties, encouraging each other, and expressing their appreciation for their help by using emojis, hashtags, and personal salutations.

The third reflective journal question asked, "Why did you choose to respond to some classmates and not to others in relation to solving data management problem?"

Students offered several reasons as to why they interacted with some classmates and not others. These reasons included tweeting to classmates who needed help, making an effort to interact with classmates they usually do not talk to in class, communicating with their friends, responding to classmates who used a different strategy or who were working on the same word problem, and replying to questions asked by their peers. Michelle noted, "I responded to some classmates who looked to be having a little bit of trouble or difficulty answering the questions. I also responded to some who used techniques and strategies that I admired and learning something from." Sophia added, "I chose to respond to some who I thought had a difference answer than I did because that's how you learn [because] Ms. Miller taught us about growth mindset." Simran stated, "I tried to respond as many different people as I could. I also tried respond to people I don't [usually] talk to." Michelle noted, "I also responded to classmates who had their answers right to give them positive feedback. I also responded to people who asked me questions

and tried to answer as best as I could." One student in particular, Avani, stated that although she tried talking to others, she was most comfortable talking to her friends and her teacher on Twitter. Therefore, students responded to questions, interacted with peers who solved the problem in a different way or seemed to be having difficulties answering the word problem, and communicating with their friends as well as classmates they usually do not interact with in the classroom.

Table 5 includes a summary of the major categories that I constructed for the student reflective journals.

Table 5

Summary of Categories for Student Reflective Journal

Questions	*Categories*
TQ1: Content of tweets	Answering word problems
	Summarizing learning
	Asking questions
	Posting multimedia resources
	Interacting on social level
TQ2: Content of responses to classmates	Asking questions
	Providing feedback
	Encouraging classmates
	Interacting on a social level
	Using emojis and hashtags

Questions	*Categories*
TQ3: Reasons for responding to classmates	Helping classmates
	Communicating with friends
	Interacting with new people
	Answering questions from classmates
	Interacting with classmates who used different strategies

Course Documents and Artifacts

The documents that I collected were the unit objectives, assessment strategies, and an instructional design template that the teacher had created for the data management unit. The artifacts that I collected were tweets from the six students who participated in this study. These tweets included the number of tweets from each student, the number of tweets that contained emojis and hashtags, and the number of retweets and tweets that were marked as 'favorite'. I conducted a content analysis for these documents and artifacts by describing the purpose, content, and use of these documents and artifacts. I also include a summary table of the categories that I constructed for each of these data sources.

Unit objectives. Data management is one of five strands in the curriculum for the Grade 8 mathematics course for this province. The Ministry of Education for this Canadian province created these unit objectives for this province to ensure consistency in

mathematics learning across the province for all students. The data management unit includes the following objectives: (a) collecting data in a variety of ways on various topics, (b) collecting, organizing, and displaying the data in relevant ways (e.g., tables, graphs, etc.), (c) identifying and recognizing terms related to data management (e.g., census, population, sample), (d) reading, interpreting, and drawing conclusions from data displayed on graphs, (e) determining the appropriate use of central tendency, (f) identifying and describing trends displayed on graphs, (g) making inferences and convincing arguments based on the analysis of a variety of graphs, and (h) comparing two attributes or characteristics using a variety of data management tools and strategies. (Ministry of Education, Mathematics Curriculum Grades 1-8, 2005).

Unit template. All Grade 8 mathematics teachers in this province are required to teach these unit objectives. However, teachers are allowed to design their own instructional strategies and assessments in order to measure student progress toward meeting these unit objectives. Therefore, Ms. Miller created a template, as shown in Figure 1, to organize the data management unit. This template includes columns for the data management concept (e.g., central tendency), the ministry objectives that match the concept, the materials needed to teach the concept (e.g. manipulatives, calculators), the assessment strategies used to measure the learning in relation to the objective (e.g., quiz, conversations with the students), and homework assigned to reinforce the concept being taught.

Date	Data Management Concept	Objectives	Materials Needed	Assessment Strategies	Homework

Figure 1. Unit Template for Data Management Unit.

Unit assessments. Instructional strategies included a mathematics word wall, think-pair-share, direct instruction, peer tutoring, group work, and hands-on learning through the use of manipulatives and objects such as yarn, marbles, and paper cups. Assessment strategies include quizzes and tests, assignments, projects, observations of student progress toward the objective, and asking students probing questions as they work individually and in groups. These assessments are designed and delivered by individual classroom teachers because the Ministry of Education does not administer any standardized tests in mathematics for Grade 8 students, either in this province or across all provinces.

Table 6 presents a summary of the categories that I constructed from an analysis of the documents.

Table 6

Summary of Categories for Course Documents

Documents	*Categories*
Unit objectives	Collecting data in a variety of ways on various topics
	Collecting, organizing, and displaying data
	Identifying data management vocabulary
	Reading, interpreting, and drawing conclusions from data on graphs
	Determining appropriate use of central tendency
	Identifying and describing trends in graphs
	Making inferences and arguments based on analysis of data
	Comparing two attributes using a variety of data management tools
Unit template	Noting data management concepts
	Noting Ministry objectives
	Noting materials needed
	Noting assessment strategies
	Noting assigned homework

Documents	*Categories*
Unit assessments	Administering quizzes and tests
	Observing student progress toward objectives
	Asking probing questions as students work
	Assigning projects

Student Tweets

Students tweeted regularly throughout the 4 week data management unit. The six students who participated in this study composed a total of 277 tweets and posted 15 visuals in the forms of pictures and videos. They "retweeted" their classmates' tweets 23 times and "liked" their classmates' tweets 47 times. Their tweets consisted of answering word problems that Ms. Miller posted, answering prompting questions that Ms. Miller posted, interacting with their classmates in a variety of ways, sharing resources with their classmates, reflecting on their learning, interacting socially, and using emojis, hashtags, and multimedia in their tweets.

In response to Ms. Miller's posted question about the images of unknown graphs, Raj tweeted, "Graph C may represent the sales of a specific product." Sakshi also responded by tweeting, "Arun can make it unbiased by asking a few randomly chosen girls and boys from each Grade 7 and 8 class their favorite sport."

A high level of interaction on Twitter occurred among students. Simran responded to one of her classmates, "To make his survey non-biased, he should ask random people in the cafeteria. What do you think?" Raj responded by tweeting, "Totally agree. Maybe next time, Arun should equally ask certain members from all the sports teams." Avani tweeted to her group members, "We should choose random people from all classes, around 6 people. Should we survey online? 😔😔😔 #math". When she realized she made an error, Sakshi tweeted, "Any other way*. Sorry forgot to write "other ways" after "any" 😂😂." In response to a classmate, Michelle tweeted, "Very true Steve, but the data could be tricky for Clara to collect because there is so much 📈."

Students shared resources with each other. Michelle tweeted, "For anyone who doesn't understand misleading graphs https://www.youtube.com/watch?v=mm2IeJLJzwE 👍👍😜 #mathisfun #8Gmath." Raj tweeted, "How to ask a survey question to avoid getting a biased answer!!! 🙂 🙂👍 #math #8G #biased #mathisfun https://www.youtube.com/watch?v=6rFxUCsnDlY." In relation to the concept of central tendency, Sakshi tweeted, "Here's a great video on choosing the best measure of central tendency https://www.youtube.com/watch?v=hQ6BnQkD43g #mean #median #mode."

Many students also reflected on their learning during the 4 week data management unit. Avani tweeted, "The cake lesson was a good visual example and made me understand the difference between bias and non bias." Simran tweeted, "The lesson was very fun to do. I really learned about histograms like that. They have a lot in common with bar graphs." Sakshi tweeted, "The cake lesson helped me learn what a

reliable and valid sample looks like." Michelle tweeted, "The test was pretty simple, still need extra time drawing the graph for the second one though #et 😜😛✏️."

Students also interacted socially on Twitter. Sakshi tweeted, "I love pineapples." Raj tweeted, "When are we getting report cards this year?" Simran tweeted, "Math is so much fun 😊😊.", and Avani tweeted, "I love pasta, it's the best! #yummy."

Finally, many students used hashtags, emojis, and multimedia resources in their tweets in order to express their feelings and emotions. Michelle tweeted the following to one of her classmates, "Great video!!! 😃 Showed how to get a good representation of the population without bias and misleading factors ✏️👍 #igetit #learning." Raj tweeted, "I would publish the second graph as I would want it to look like there is no difference between murder and attempted 😈#maths." Simran tweeted, "We should use a bar graph of how many people use snap chat facebook etc 😊😊😊😊 #mathassignment. Avani tweeted, "I didn't expect the central tendency part because we never really did it in class so I didn't think it would be on the test 😅." Figures 2, 3, and 4 displays interactions between students and Ms. Miller and Figures 5, 6, and 7 shows interactions between students.

Figure 2. Avani sharing Ms. Miller's lesson.

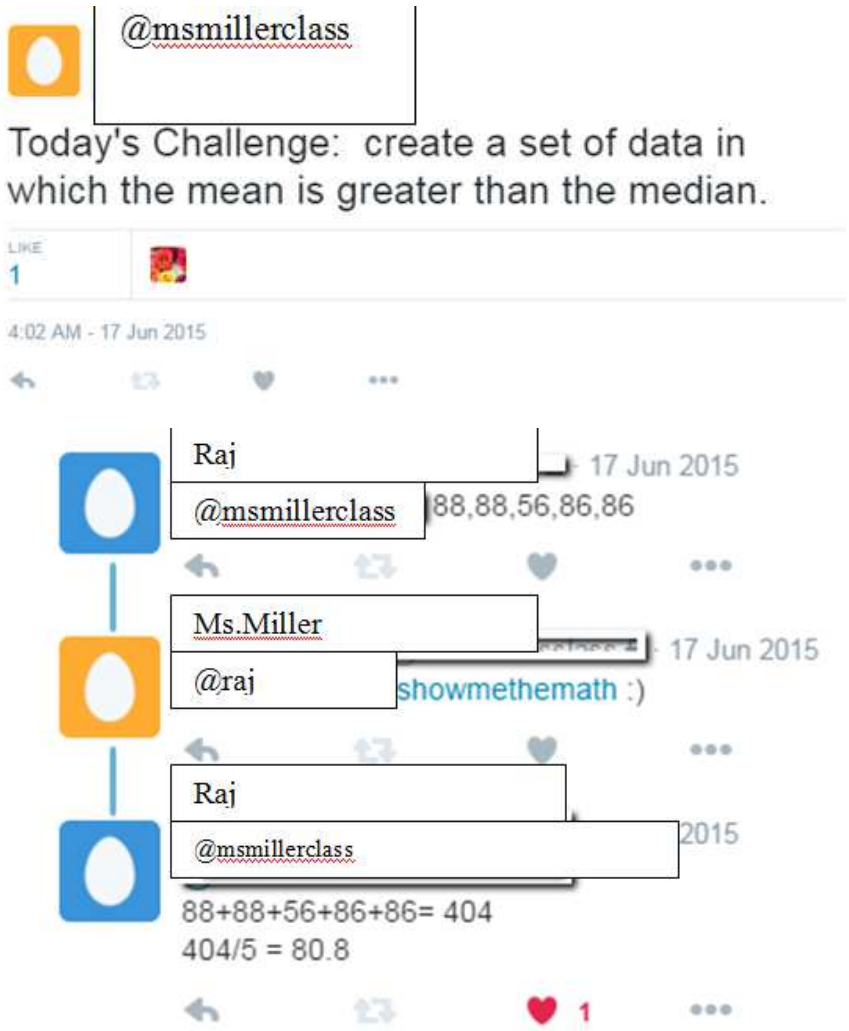

Figure 3. Raj responding to Ms. Miller's word problem.

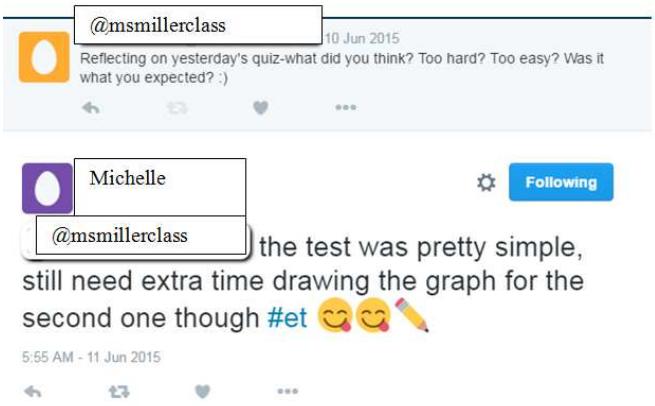

Figure 4. Michelle sharing her thoughts on a quiz

Figure 5. Simran sharing a central tendency lesson with her classmates

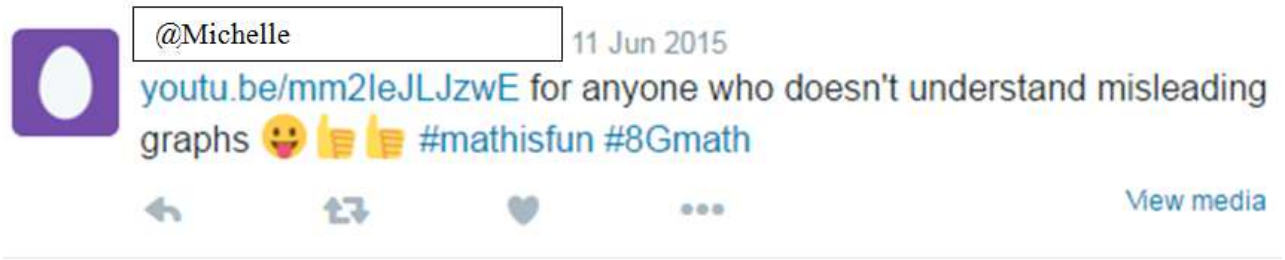

Figure 6. Michelle posting a YouTube video on misleading graphs for her classmates

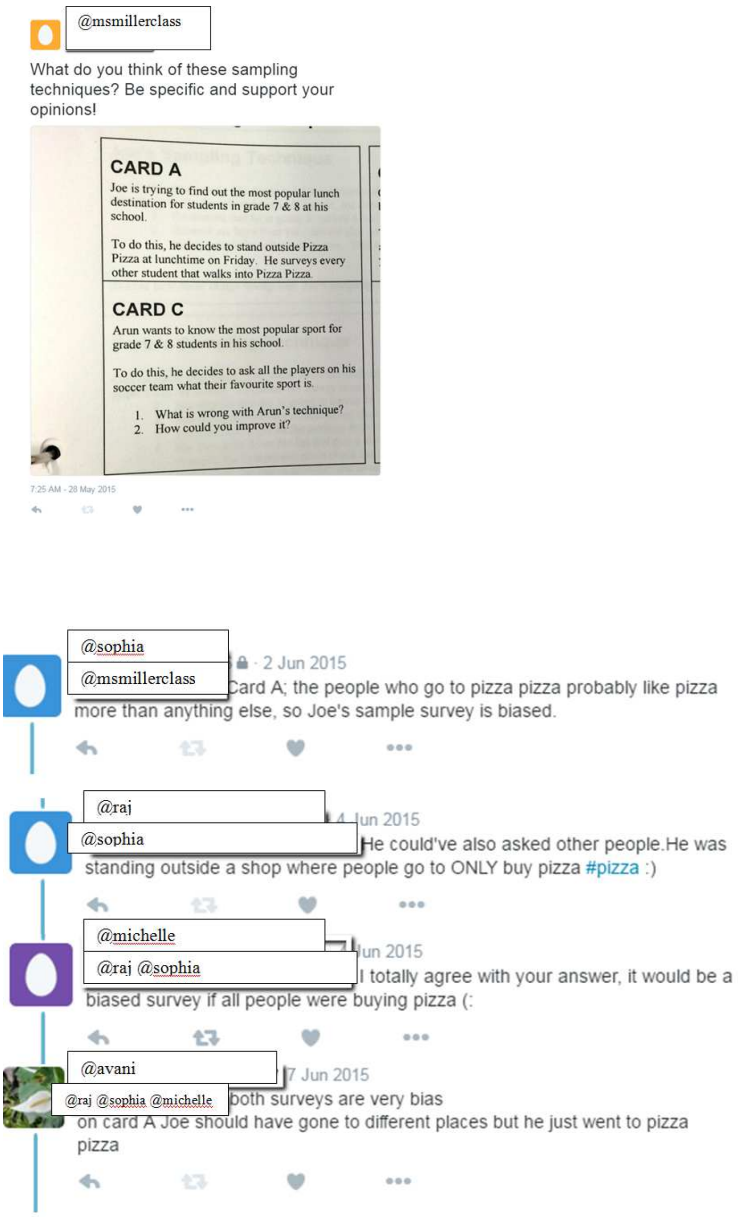

Figure 7. Sophia, Raj, Michelle, and Avani having a conversation about a sampling scenario

Thus, students tweeted in a variety of ways, which included responding to their teacher, interacting with each other academically and socially, sharing resources, reflecting on their learning, and using emojis, hashtags, and multimedia resources. Table

7 provides a summary of the categories that I constructed in relation to the analysis of student tweets.

Table 7

Summary of Categories for Students' Tweets

Answering word problems that teacher posted
Responding to prompts that teacher posted
Interacting with classmates socially
Agreeing with classmates on answers to word problems
Asking for classmates' opinions on word problems
Collaborating in groups on assignments
Explaining answers to word problems
Offering alternative explanations and answers to word problems
Clarifying tweets when mistakes were made
Reflecting on their learning
Sharing resources
Using hashtags, emojis, and multimedia to express emotions and feelings

Level II Data Analysis

At the second level, I examined the categorized data across all data sources to determine emerging themes and discrepant data. These themes and discrepancies formed

the key findings of this study, which I analyzed in relation to the central and related research questions.

Emergent Themes

Theme 1. The teacher used Twitter to help students learn mathematics in a variety of ways, including extending their learning by asking probing questions, posting daily word problems and challenges, allowing students to take on the role of a teacher, interacting with students by responding to their questions and providing feedback, and effectively using the Twitter platform by posting multimedia resources such as pictures and YouTube videos.

Theme 2. The teacher believed that Twitter was a valuable tool to help students improve their learning in mathematics because students assumed the role of teacher, built a sense of community through collaboration and interactions, actively participated, shared multimedia resources, and reflected on their learning.

Theme 3. The majority of students believed that Twitter was a valuable tool to improve their learning in mathematics because they were able to interact with the teacher and their classmates outside of the classroom. These interactions included collaborating on group assignments, comparing their work in order to learn other ways to solve word problems, interacting with their teacher by answering probing questions and receiving feedback, reflecting on their learning, and viewing multimedia resources posted by their teacher and classmates.

Theme 4. Documents such as unit objectives and a unit template supported student learning in mathematics by ensuring that students met the Ministry of Education

expectations for data management concepts in Grade 8 and that student performance was comprehensively assessed.

Theme 5. Artifacts such as student tweets supported student learning in mathematics in a variety of ways, including providing opportunities to share resources, interact with classmates, collaborate with classmates, and extend their learning.

Theme 6. When the teacher integrated Twitter into mathematics instruction, student engagement was positively impacted because this social media tool helped students to build a community and a positive climate for learning data management concepts by interacting and collaborating with each other as well as using the features of Twitter to connect with each other, such as hashtags and emojis.

Theme 7. When the teacher integrated Twitter into mathematics instruction, student learning was positively impacted because this social media tool provided multiple opportunities for students (a) to understand the different ways in which word problems could be solved, (b) to receive feedback from their teacher and classmates, and (c) to analyze visuals and videos posted by their teacher and classmates.

Discrepant Data

For case study research, discrepant data is data that challenges the theoretical proposition of the study (Yin, 2014). The theoretical proposition for this study was that social presence on Twitter *positively* impacts student engagement and learning when a mathematics teacher integrates this social media tool into mathematics instruction. The results of this study support that theoretical proposition.

Discrepant data, however, did emerge in relation to one student, Dylan, who consistently expressed negative beliefs about the integration of Twitter into mathematics instruction in the classroom. Dylan stated,

> I feel there is no need to use Twitter. I like the old days; well, not the old days but I like when teachers stand up in front of the chalkboard and give you an actual lesson. I feel that helps me more than Twitter. I found Twitter was alright, but I personally would not do it next time.

Dylan's unwillingness to support the use of Twitter in the classroom stemmed from the platform itself. Dylan noted, "Using a device is...more complicated for me because...I learn better when the teacher actually sits me down one on one and or even just explaining it to the class." Dylan added,

> It was all of us on it so whose tweets do [you] read because they are so many and people are responding to each other so you have to follow the conversation from the beginning, which takes a while. . .You could only use so many characters, like 140, so that can get complicated trying to write your tweet in that many characters.

Dylan also believed that Twitter did not help him in learning data management concepts, adding, "I did not get very involved because I felt Twitter was not necessary and I just used the worksheets that we've gotten." Dylan added,

> I love working in groups where we figure out one problem, and then we have just this one big board and we figure it out as a group. I love that! I love when...teachers give you actual items to work with. . . If you're doing algebra,

they'll give you actual items and then they'll explain it using the items so you can [learn] too with the items.

However, Dylan did acknowledge one benefit of Twitter when he noted, "You get to connect with more people when you're not around the person." Dylan also believed that technology is a significant part of education when he stated, ""I think it'll go somewhere...[because] the 21st century...will be the new way of teaching, not necessarily Twitter, but using devices as a way to learn math in the classroom and other topics." Dylan also recognized another benefit of technology when he stated, "It's easier because if you forget your homework, it's on Twitter and there it is....! What else? Faster, easier, you always have it with you most of the time because you always have a device with you nowadays." Thus, although Dylan identified a few advantages of Twitter in the classroom, he believed that his overall experience with Twitter was not positive due to his personal learning style and the features of Twitter.

Evidence of Trustworthiness

Merriam (2009) contended that generating trustworthy results in an ethical manner is an integral part of qualitative research. Merriam believed that this trustworthiness can be achieved by paying close attention to the conceptualization of the study in addition to the manner in which the data is collected, analyzed, and interpreted. For this study, a variety of strategies were used to improve the credibility, transferability, dependability, and confirmability of this qualitative research.

Credibility

Credibility, Merriam (2009) maintained, is concerned with ensuring that the results of the study are believable. Merriam presented five strategies that a qualitative researcher can use to ensure credibility: triangulation, member checks, adequate engagement, reflexivity, and peer review. For this study, I used the strategies of triangulation and peer review to improve the credibility of this study. I used triangulation by comparing and contrasting data from multiple data sources, including student and teacher interviews, student and teacher reflective journals, course documents, and student tweets. I also used peer review by asking an educational colleague familiar with my research to review the findings for their plausibility. I met with this colleague six times during the implementation of this study, and I maintained written accounts of these peer-debriefing sessions, transferring my notes to NVivo, as Creswell recommended (2007).

Transferability

Transferability, Merriam (2009) noted, refers to the degree to which the results of a qualitative study can be transferred to other settings. Merriam outlined two strategies to enhance transferability, which include rich, thick descriptions and typicality of sample. For this study, I used the strategy of rich, thick description by providing a detailed description of the setting, the participants, and the findings, which included direct quotes from the interview and reflective journal data. I also included samples of student tweets in the analysis of the data. Additionally, I used the strategy of typicality of sample by selecting a Grade 8 mathematics course that was typical of other mathematics courses in the district and the province.

Dependability

Dependability, Merriam (2009) noted, is defined as the extent to which the results of the research study can be replicated. In essence, dependability means whether or not the same results would be achieved if the study was repeated. Merriam suggested four strategies to increase dependability in qualitative research: triangulation, peer examination, clarification of the investigator's position, and an audit trail. For this study, I used the strategies of triangulation, peer review, and an audit trail. I used triangulation by comparing and contrasting data from multiple data sources, as described earlier. I also used the strategy of peer review by asking an educational colleague familiar with my research to determine the plausibility of these results. I also used the strategy of an audit trail by maintaining my memos and journals using the NVivo software program as well as including in the appendices sample letters of cooperation and consent and the instruments that I used to collect data.

Confirmability

Confirmability refers to the degree by which the results from a qualitative study can be corroborated or confirmed by other individuals (Miles, Huberman, & Saldana, 2014). Strategies to enhance confirmability include reflexivity and transparency. For this study, I used the strategies of reflexivity and transparency. I used reflexivity by maintaining a researcher's journal in which I described the decisions that I made during data collection and analysis as well as my discussions with the peer reviewer. In addition, I reflected on my personal assumptions and biases about student use of Twitter to learn

mathematics. I also used the strategy of transparency by explicitly stating the research method, sequence, and conclusions of this study (Miles et al., 2014).

Results

In this section, the results or findings of this study are analyzed in relation to the themes and discrepant data that emerged from the coding and constructed categories. The related research questions are presented first because the central research question includes a synthesis of all of the findings.

The first related research question asked, "How does a teacher use Twitter to help students improve their learning in mathematics?" The finding for this related research question was that the teacher used Twitter to help students improve their learning in mathematics in a variety of ways, including extending their learning by asking probing questions, posting daily word problems and challenges, allowing students to assume the role of a teacher, interacting with students by responding to their questions and providing feedback, and effectively using the Twitter platform by posting multimedia resources such as pictures and YouTube videos.

Teacher interview data and teacher reflective journal data as well as course documents supported this finding. To extend student learning, Ms. Miller reported that she posted daily word problems for the students to answer at home such as, "Create a set of data in which the mean is greater than the median," and "Find a set of data with 5 numbers where the mean is 42." Ms. Miller also posted a number of graphs in order to encourage students to analyze graphs from a critical lens. She asked probing questions such as, "What is wrong with this graph?" and "How does this graph demonstrate bias?"

Ms. Miller also posted pictures of the learning that occurred in class so they could review their work, teacher notes, and the work of their classmates, because this review was not always possible during class time. For example, Ms. Miller posted pictures of students' work on chart paper as they were problem solving as well as pictures of the notes she wrote on the blackboard while teaching a data management concept. Ms. Miller asked probing questions in order to extend students' critical thinking and reasoning skills, such as "How would you change the graph to make it bias?" and "Why do you think that is?" Ms. Miller also posted videos to enhance students' understanding of concepts; for example, she posted a video about bias in graphs, which students viewed at home. Ms. Miller also reported that students began to answer their classmates' questions, allowing them to assume the role of the teacher, which motivated students to answer their classmates' questions before Ms. Miller could respond. Therefore, as the weeks progressed, Ms. Miller reduced her tweeting because students helped each other learn the concepts and complete the word problems with accuracy. Ms. Miller also believed that the use of Twitter assisted her in meeting unit objectives in data management such as (a) identifying data management vocabulary, (b) reading, interpreting, and drawing conclusions from data on graphs, (c) identifying and describing trends in graphs, (d) making inferences and arguments based on analysis of data, and (e) asking probing questions to assess their understanding. Thus, Ms. Miller used a number of instructional strategies to help students enhance their learning of data management concepts, including asking probing questions, posting word problems and videos, answering their questions, and allowing them to assume the role of the teacher.

The second related research question asked, "How does a teacher perceive the value of students using Twitter to improve their learning in mathematics?" The key finding was that the teacher believed that Twitter was a valuable tool to help students improve their learning in mathematics because students assumed the role of teacher, built a sense of community through collaboration and interactions, actively participated in the instructional activities, shared multimedia resources, and reflected on their learning.

Teacher interview data and teacher reflective journal data support this finding. Ms. Miller believed that Twitter was a valuable tool for students to use in improving their learning in mathematics. Ms. Miller reported that students often answered questions directed to her, allowing them to assume the role of a teacher. Ms. Miller added,

> I found that if I didn't have time to respond, what would happen is that other kids would jump in and help the other students and answer the question for them so that was really awesome because they just seemed so much more independent and I didn't feel like I had to always respond to them right away because they were actually teaching each other.

Ms. Miller also believed that students built a sense of community in the classroom as a result of using Twitter in the mathematics classroom. Students who normally did not communicate in the classroom now talked to their classmates because Twitter gave them the opportunity to interact with their peers. These interactions included answering classmates questions, asking probing questions, and providing feedback and positive comments on answers to word problems. In particular, Ms. Miller believed ESL students were more comfortable interacting with their classmates because of their participation on

Twitter. Ms. Miller also believed that the 140 character limit helped ESL students to express themselves more confidently because they did not have to worry about proper spelling and grammar. Additionally, Ms. Miller noted that students independently posted and shared multimedia resources, most notably, YouTube videos on a variety of concepts related to data management, such as central tendency, bias, and data management vocabulary. These videos enhanced student learning of data management concepts in order to meet learning objectives. Finally, Ms. Miller believed that students were able to reflect on their learning because of their interactions on Twitter. Students realized where they required help based on their conversations with their classmates and teacher as well as the probing questions posed by others. Because students were able to see the different ways in which word problems were solved, they were able to assess their learning and reflect on the many ways in which a problem could be solved. As a result, Ms. Miller believed that Twitter was an important tool in helping students learn data management concepts because it gave them the opportunity to teach their classmates, to increase interactions and participation through community building, to share multimedia resources, and to reflect on their learning and understanding of data management concepts.

The third related research question asked, "How do the students perceive the value of using Twitter to improve their learning in mathematics?" The key finding was that the majority of students believed that Twitter was a valuable tool to improve their learning in mathematics because they were able to interact with each other outside of the classroom. Students collaborated on group assignments, compared their work in order to

learn other ways to solve word problems, and interacted with their teacher by answering probing questions and receiving feedback. Students also believed the integration of Twitter into mathematics instruction was valuable because they were able to reflect on their learning and to enhance their learning by viewing multimedia resources posted by their teacher and classmates.

Student interview data and student reflective journal data supported this finding. Students found themselves not only interacting with their friends on Twitter but also with classmates whom they normally did not interact with in the classroom. These interactions helped to build a learning community in the classroom. Michelle stated,

> It [made] me more open to my classmates so I can talk to them about math so other classmates who have different ideas than I can actually collaborate with them and talk to them about it and that helped me to understand data management a lot better.

Students also reported that they valued opportunities to communicate with their classmates about their group assignments. Twitter allowed them to continue their conversations outside of school by exchanging ideas about the project, sharing the data they had collected during the day, and ensuring that they analyzed and depicted their data accurately. Students also believed that the opportunity to discuss the different ways in which word problems could be solved as well as the opportunity to ask Ms. Miller questions when they experienced difficulties completing word problems also enhanced their learning about data management concepts. Students also believed that their learning improved when they were able to answer the probing questions that Ms. Miller posed,

such as, "Do you think your data would change if you recalculated without outliers?" In addition, students believed that Twitter allowed them to reflect on their learning because they were able to understand where they experienced difficulties completing the word problems. Furthermore, students reported that the 140 character limit on Twitter forced them to reflect and think critically about how to complete word problems accurately and concisely. Avani added, "It really got me thinking, and it got me working harder than I usually do." Lastly, students believed that Twitter was a valuable tool to help them learn data management concepts because classmates posted multimedia resources to enhance their learning. These multimedia tools included YouTube videos on central tendency, methods in which bias can be depicted in graphs, misleading graphs, and data management terminology. Students also posted pictures of the work completed in class as well as Ms. Miller's lessons delivered on the blackboard. These visuals provided opportunities for students to revisit the classroom teaching and learning on their own time. Thus, students believed that using Twitter was a valuable tool to learn data management concepts because it provided opportunities to interact with each other and their teacher in a variety of ways, to reflect on their learning, and to view YouTube videos and other visuals of the learning that occurred in their classroom.

The fourth related research question asked, “How do documents and artifacts such as tweets and problem solving notebooks support student learning in mathematics?” In relation to documents, one of the key findings was that the Ministry of Education curriculum document, which included the objectives for the Grade 8 data management unit, and a planning template, which Ms. Miller designed, were used to provide direction

for student learning in mathematics. Ms. Miller used the Ministry of Education objectives for mathematics to ensure students would meet the objectives for the data management unit. Ms. Miller designed the template in order to plan an effective instructional unit that included the data management concepts, ministry objectives, materials needed, assessment strategies to ensure students met the objectives for the Grade 8 data management unit, and daily homework assignments.

In relation to artifacts, another key finding was that student tweets were also used to support student learning in this Grade 8 data management unit. Tweets supported student learning in mathematics by providing opportunities to practice data management concepts by answering the word problem challenges that Ms. Miller posted, such as "Think of 2-3 scenarios which would result in a positive correlation, a negative correlation and no correlation. Be sure to comment on each other's ideas." and "List the similarities and differences between a histogram and a bar graph." Tweets also supported student learning of data management because students frequently received feedback from their classmates, such as when Simran tweeted, "Yes, that way it is non-biased, and the survey results can be reliable. Are there any ways we can make improve Joe's method?" and Michelle tweeted, "Very true, Alan, but the data could be tricky for Clara to collect because there is so much." Students had the opportunity to tweet alternative explanations and answers to word problems, such as when Raj tweeted, "Maybe next time, Arun should equally ask certain members from all the sports teams" and Sophia tweeted, "And he should also make sure that the people he is surveying are different genders and ages."

The ability to collaborate on group assignments outside of school also helped students to practice data management concepts, such as when Avani tweeted, "I got a question; how are we going to survey the Grade 8 [classes] for our assignment? Should we just pick a few people from each class?" and Simran tweeted, "I have an idea. Maybe we can choose six people from each class and survey them?" In addition, using Twitter gave students opportunities to share resources in the form of YouTube videos and class notes to support their learning of data management concepts. For example, Michelle shared a video on misleading graphs, and Raj shared a video on bias and unbiased graphs. Students also posted pictures of blackboard lessons that Ms. Miller conducted and the work they completed in class, which allowed students to review the concepts on their own time at home. However, problem solving notebooks were not included in the data collection process because Ms. Miller did not choose to use them for this instructional unit.

The central research question asked, “How does social presence on Twitter impact student engagement and learning when a mathematics teacher integrates this social media tool into mathematics instruction?”

All data sources supported the key finding for the central research question that social presence on Twitter had a positive impact on student engagement and learning. Ms. Miller expressed her belief that social presence on Twitter impacted student engagement and learning in mathematics in a positive manner. Through her interview and reflective journal responses, Ms. Miller believed that integrating Twitter into the data management unit positively impacted student engagement because a sense of classroom

community was built through interactions with a variety of classmates, which in turn helped to build a positive classroom climate. In addition, Ms. Miller believed that students were engaged due to the features of Twitter that allowed them to use emojis and hashtags as well as posting visuals and videos to support their learning. Ms. Miller believed that student learning was also positively impacted because the use of Twitter gave students the opportunity to practice these concepts by answering posted word problem and challenges, responding to probing questions to extend their learning, and assuming the role of a teacher by answering their classmates' questions in order to improve their understanding of specific concepts. In addition, Ms. Miller believed that the use of Twitter provided her with multiple opportunities to provide specific and immediate feedback to her students as well as effectively using the Twitter platform by posting multimedia resources such as pictures and YouTube videos to improve their learning of specific data management concepts. Furthermore, the use of Twitter allowed students to reflect on their learning because they were able to determine their difficulties in understanding concepts when answering word problems as well as identifying the various ways in which word problems could be solved.

Student interview and reflective journal data also supported the positive impact of Twitter on student engagement and learning. Five out of six students reported that they enjoyed using Twitter to learn data management concepts. These students reported they were engaged because they had the opportunity to collaborate online with all their classmates, not just their friends, which they believed created a more positive classroom environment because they were willing to work with classmates they had not worked

with before. Furthermore, students reported that Twitter engaged them because they were encouraged to express their emotions and thoughts through emojis and hashtags as well as by adding pictures and videos related to mathematics and data management concepts to their tweets. These students also cited specific advantages of interacting on Twitter that positively impacted their learning, which included providing opportunities to communicate with each other on their group assignments, learning the various ways in which word problems could be solved, and answering probing questions and receiving feedback from Ms. Miller. These opportunities encouraged students to reflect on their learning and to improve their understanding of specific data management concepts in order to express their ideas in 140 characters. Finally, students believed their learning about data management concepts was enhanced due to the multimedia resources that their teacher and classmates posted, which included YouTube videos and pictures of the learning that occurred in the classroom.

Thus, both the teacher and the students believed that the integration of Twitter into instructional activities impacted student engagement and learning and helped them to meet the Ministry of Education objectives for the data management unit. Students were engaged because of the increased opportunities to collaborate with all of their classmates and to add emojis, hashtags, visuals, and videos to their tweets. Student learning was also positively impacted because students were provided with many opportunities to learn data management concepts and meet the ministry objectives, such as displaying data in a variety of ways (e.g., pie graphs, line graphs, bar graphs, and scatter plots) and using a variety of strategies to make convincing arguments about the data. Students met these

objectives by solving problems, answering probing questions, examining the many ways in which their classmates solved problems, and receiving feedback from both Ms. Miller and their classmates.

Table 8 is a summary of the results for this study in relation to the related and central research questions.

Table 8

Summary of Key Findings

Research Question	*Key Findings*
RRQ1: Teacher use	Posting daily word problems and challenges
	Asking students probing questions
	Encouraging students to assume role of teacher
	Providing feedback to students on their work
	Answering students' questions
	Posting multimedia resources
RRQ2: Teacher perceptions	Building classroom community
	Encouraging students to assume role of teacher
	Increasing student participation
	Reflecting on their learning
	Sharing multimedia resources

Research Question	*Key Findings*
RRQ3: Student perceptions	Collaborating on group assignments
	Comparing each other's work
	Answering teacher's probing questions
	Receiving student & teacher feedback
	Reflecting on their learning
	Sharing multimedia resources
RRQ4: Document Analysis	Defining Ministry objectives
	Using unit planning template
	Answering word problems posted by teacher
	Receiving student & teacher feedback
	Providing multiple ways to solve problems
	Collaborating on group assignments
	Sharing multimedia resources

Research Question	*Key Findings*
Central RQ: Impact on student engagement & learning	Building classroom community
	Collaborating with variety of classmates
	Increasing positive climate in classroom
	Using emojis and hashtags in tweets
	Posting visuals and videos
	Answering probing questions
	Assuming role of teacher
	Receiving student & teacher feedback
	Collaborating on group assignments
	Reflecting on their learning
	Considering many ways to solve problems
	Supporting affective category of social presence theory
	Supporting interactive category of social presence theory
	Supporting cohesive category of social presence theory

Summary

In summary, this study reveals a positive relationship between social presence and student engagement within a community of learners as well as a positive relationship between social presence and perceived learning. Students presented themselves as "real" because they connected with one another while communicating in an online learning environment (i.e., Twitter) by using emojis, hashtags, visuals, videos, sharing personal preferences, asking questions to clarify their understanding of data management concepts, communicating agreement about the answers to word problems, demonstrating appreciation for learning the different methods in which word problems could be solved, engaging in conversations about data management concepts, and using personal pronouns and first names in their interactions with each other. Therefore, Twitter demonstrated a positive impact on student engagement and perceived learning in a Grade 8 mathematics classroom.

Chapter 5 includes an interpretation of the findings. It includes an introduction, which restates the purpose and nature of the study, an interpretation of the findings in relation to the literature review and the conceptual framework of the study (i.e., the social presence theory). In addition, this chapter includes a discussion of limitations and recommendations for future research, and implications for social change. Chapter 5 also includes a conclusion, which captures the significance of the study.

Chapter 5: Discussion, Recommendations, and Conclusion

The purpose of this qualitative study was to explore how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit. An embedded single case study design was particularly appropriate for this study because I collected and analyzed data from multiple sources in order to present a rich picture of the case. Although several researchers have used social presence theory as a framework for their studies on social media in the classroom, the majority of these studies have been conducted in higher education institutions and not in elementary and secondary schools. This study, therefore, contributes to the body of knowledge about how middle school teachers use social media such as Twitter to help students engage in learning.

The findings of this study indicate a positive relationship between social presence and student engagement and learning. The first key finding was that the teacher used Twitter to help students improve their learning in mathematics in a variety of ways, including extending their learning by asking probing questions, posting daily word problems and challenges, allowing students to assume the role of a teacher, interacting with students by responding to their questions and providing feedback, and effectively using the Twitter platform by posting multimedia resources such as pictures and YouTube videos. The second finding was that the teacher believed that Twitter was a valuable tool to help students improve their learning in mathematics because students assumed the role of teacher, built a sense of community through collaboration and interactions, actively participated in the instructional activities, shared multimedia

resources, and reflected on their learning. The third key finding was that the majority of students believed that Twitter was a valuable tool to improve their learning in mathematics because they were able to interact with each other outside of the classroom. Students collaborated on group assignments, compared their work in order to learn other ways to solve word problems, and interacted with their teacher by answering probing questions and receiving feedback. Students also believed the integration of Twitter into mathematics instruction was valuable because they were able to reflect on their learning and to enhance their learning by viewing multimedia resources posted by their teacher and classmates. The fourth key finding was that the Ministry of Education curriculum document, which included the objectives for the Grade 8 data management unit, and a planning template, which the teacher designed, was used to provide direction for student learning in mathematics. A fifth key finding was that student tweets supported student learning in this Grade 8 data management unit, particularly by providing them with opportunities to collaborate on assignments outside of school. Thus, Twitter positively impacted student engagement and learning by promoting student collaboration, contributing to a positive classroom climate, and building a sense of community in the classroom where students were learning and working together to understand data management concepts.

Interpretations of Findings

My interpretation of the findings is informed by the literature review and the conceptual framework. In what follows, I present the interpretation of findings first for the related research questions, and then for the central research question. I have presented

the findings in this way because my interpretation of the findings for the central research question synthesizes the findings from the related research questions.

Teacher Use of Twitter

The key finding was that the teacher used Twitter to help students improve their learning in mathematics in a variety of ways, including posting daily word problems and challenges, extending their learning by asking probing questions, allowing students to assume the role of a teacher, interacting with students by responding to their questions and providing feedback, and effectively using the Twitter platform by posting multimedia resources such as pictures and YouTube videos.

Current research supports this finding. In a study about cognitive communication, Andrade et al. (2012) integrated the use of Twitter into a PowerPoint presentation in a master's degree course in Portugal. Andrade et al. found that integrating Twitter into their presentation allowed students to comment, question, and debate concepts in real time. In my study, Grade 8 students also participated in these types of teacher-supported interactions; they provided feedback to each other, asked their classmates and the teacher for clarification, and discussed the answers to word problems and the different ways in which those problems could be solved. In another study, Elavsky et al. (2011) explored the use of Twitter in a university media and democracy course in which the instructor projected the Twitter feed in a large lecture hall once a week. Results indicated that students' participation and engagement in the course increased because even though the majority of tweets occurred during class time, students still tweeted outside of class time. The results from my study also indicated that Grade 8 students engaged and participated

on Twitter because they responded to probing questions that the teacher posed and to questions posed by their classmates. In addition, the Grade 8 teacher used hashtags in her posts, prompting students to generate hashtags and use emojis in their Twitter posts and posting links to video and pictures of their learning, which demonstrated their engagement in learning data management concepts. In another study of Twitter as an instructional tool, Rinaldo et al. (2011) examined how a marketing teacher used Twitter to engage students in dialogue about marketing concepts. The teacher tweeted about course content and class announcements. Rinaldo found that teacher use of Twitter positively impacted students' beliefs about being prepared to meet their career goals educational objectives. In my study, the teacher believed that using Twitter in the Grade 8 mathematics classroom helped students understand data management concepts and meet the objectives of the data management unit.

In another study, Lowe and Laffey (2011) examined how a teacher used Twitter to post information regarding a variety of marketing concepts, and found that more than 65% of students followed the teacher's tweets. However, interactions among students were limited, indicating that Twitter was a passive form of communication. In contrast, the findings of my study indicated that Twitter was an active form of communication because Grade 8 students responded to the probing questions and feedback that the teacher posted. In addition, the teacher answered students' questions promptly when they encountered problems solving some of the word problems. The difference between Lowe and Laffey's study and my study could be attributed to the fact that the Grade 8 mathematics class met every day and the class included only 25 students, whereas

students in the marketing course met several times a week and the class included 123 students. Thus, both instructional time and class size may have impacted the level of interaction among students and the classroom environment. In other research, Blessing et al. (2012) conducted a study of a university level psychology course to explore teacher use of Twitter to reinforce instructional concepts. In this quasi-experimental study, students were divided into two groups. In one group, the teacher sent students psychology related tweets every day, and in the other group, the teacher sent students simple jokes every day. Results demonstrated that students who received the psychology related tweets that reinforced instructional concepts performed significantly better on the five examinations that the teacher gave throughout the semester than the students who received the humor-related tweets. Even though my study was qualitative, I found that the teacher used Twitter to reinforce data management concepts by answering students' questions and asking them probing questions.

Teacher Perceptions about Twitter

The key finding was that the teacher believed that Twitter was a valuable tool to help students improve their learning in mathematics because students assumed the role of teacher, built a sense of community through collaboration and interactions, actively participated in the instructional activities, shared multimedia resources, and reflected on their learning.

Current research supports this finding. Vazquez-Cano (2012) explored how Twitter was integrated into an interdisciplinary program to improve linguistic competence in reading and writing in a Spanish language class, a social sciences class,

and a natural sciences class. Vazquez-Cano found that teachers believed that Twitter promoted student self-discovery, self-learning, and collaboration. In my study, the Grade 8 teacher also believed that the use of Twitter gave students the opportunity to reflect on their learning, to recognize where they were having difficulties understanding data management concepts, and to examine the variety of ways a word problem could be solved based on the responses of their classmates. In another study, Pauschenwein and Sfiri (2010) examined the motivation of adult learners to use Twitter during online training courses. Results indicated that these adult learners recognized Twitter as an effective tool to discuss course content. In my study, the Grade 8 teacher also found that Twitter was an effective tool for students to use in their discussion of course content because they exchanged ideas about data management concepts, taught each other, and participated in social conversations.

In other related research, Dunlap and Lowenthal (2009) investigated teacher use of Twitter to enhance social presence in an online instructional design and technology course. Dunlap and Lowenthal found that teachers believed that students were frequently engaged in collaboration, information sharing, brainstorming, and problem solving. Teachers also believed that students used Twitter for a variety of reasons including asking questions about course material, sharing their personal views, and sending messages to teachers about issues related to group assignments. In my study, the teacher also believed that Grade 8 students used Twitter to engage in learning mathematics by responding to probing questions, collaborating on word problems and group projects,

sharing personal information, and sharing information by posting YouTube videos and pictures of their learning.

Student Perceptions about Twitter

The key finding was that the majority of students believed that Twitter was a valuable tool to improve their learning in mathematics because they were able to interact with each other outside of the classroom. Students collaborated on group assignments, compared their work in order to learn other ways to solve word problems, and interacted with their teacher by answering probing questions and receiving feedback. Students also believed the integration of Twitter into mathematics instruction was valuable because they were able to reflect on their learning and to enhance their learning by viewing multimedia resources posted by their teacher and classmates.

Current research supports this finding. Wright (2010) explored Twitter as a community building tool in practicum experiences related to teacher education. Wright found that pre-service education students believed they were increasingly reflective when they used Twitter. In my study, based on their classmates' tweets, Grade 8 mathematics students also reflected on how they solved word problems and the concepts they needed to practice. In another study, Domizi (2013) examined the use of Twitter in a weekly graduate seminar course to enhance learning and classroom community and discovered that students believed Twitter was useful for sharing resources and extending conversations about their mathematical learning. Grade 8 students in this study also believed that they got to know each other better by sharing personal information, posting YouTube videos and visual related to data management, and discussing the answers to

the word problems that the teacher posted. In related research, Yakin and Tinmaz (2013) explored the use of Twitter in a computer applications course and found that students believed that Twitter was a good place to share information and knowledge, communicate about course content, and post pictures. In my study, Grade 8 students also believed that Twitter allowed them to share their knowledge in terms of how to solve word problems, post videos and visuals, and ask questions to clarify understanding in order to better understand data management concepts.

Some studies do not support the finding that students believe the use of Twitter improves their engagement and learning. Gunuc et al. (2013) explored the experiences of Grade 7 students in Turkey who used Twitter as a communication tool and found that 67% of students did not find Twitter an effective tool for communication. However, in my study, the majority of Grade 8 students did find Twitter an effective tool in terms of engagement and learning because they actively communicated with each other to better understand data management concepts. This difference in findings could be attributed to the fact that Grade 7 students in the Turkey study only used Twitter for 12 days whereas Grade 8 students in this study used Twitter for 4 weeks. In addition, these differences in findings could be due to the fact that the Grade 7 students in Turkey were not aware of the many features of Twitter, such as sending and receiving direct messages and the ability to post multimedia resources, whereas the Grade 8 students actively posted visuals and videos to enhance their learning of data management concepts. In other research, Jacquemin et al. (2014) conducted a study in which Twitter was integrated into an undergraduate and graduate biology classroom. In relation to student assessment of

Twitter use, Jacquemin et al. found that 100% of graduate students did not believe Twitter to be an effective tool for course discussion, and even though 67% of students believed that Twitter exposed to them to valuable information about biology, they did not consider Twitter a valuable tool for learning. Both studies indicated that Twitter might not be the best tool to integrate into a course because Grade 7 students in Gunuc's study preferred to use Facebook and students in Jacquemin et al.'s study preferred online discussions in a learning management system such as Blackboard. However, in my study, Grade 8 students found Twitter to be a valuable tool for social interactions and also for academic interactions they experienced with peers and the teacher in relation to learning about data management concepts.

Supporting Documents and Artifacts

The key finding was that the Ministry of Education curriculum document, which included the objectives for the Grade 8 data management unit, and a planning template, were used to provide direction for student learning in mathematics. Student artifacts such as Tweets also supported student learning in mathematics, particularly by providing students with opportunities to collaborate on assignments outside of school.

Current research supports this finding. Yakin and Tinmaz (2013) examined the use of Twitter in a computer applications course and found that college students used Twitter to improve their learning, such as sharing knowledge about course content, asking their instructor and peers questions to clarify understanding, communicating ideas with their classmates, and finding other ways to use Twitter, such as sending direct messages to each other and sharing photos and lecture notes. In relation to my study,

Grade 8 students also shared different solutions to word problems with their peers, helped each other when they encountered difficulties, and posted class work, visuals, and videos related to data management. In another study, McArthur and Bostedo-Conway (2012) explored the use of Twitter in terms of enhancing instructor-student communication and relationships and found that students who used Twitter believed that their instructors were more approachable and interactive. In relation to my study, student interactions with the teacher increased as students answered the teacher's probing questions and asked clarifying question to enhance their understanding of data management concepts. In other supportive research, Kassens-Noor (2012) investigated teacher use of Twitter in an urban planning class to improve active and informal learning and found that Twitter use facilitates the sharing of ideas, which helps students to construct knowledge. In relation to my study, Grade 8 students also shared their ideas about data management concepts with each other. However, Kassens-Noor also found that Twitter may prevent self-reflection and critical thinking because it does not support knowledge retention. In my study, Grade 8 students did engage in self-reflection because they became aware of their gaps in understanding data management concepts when they read the tweets of their classmates and the teacher. Furthermore, Grade 8 students also engaged in self-reflection when they understood the many ways in which word problems could be solved.

Impact on Student Engagement and Learning

All data sources supported the key finding for the central research question that social presence on Twitter had a positive impact on student engagement and learning. Current research also supports this finding. Evans (2014) explored the role of Twitter in

enhancing learning in an undergraduate business class and found that the more students used Twitter, the more engaged they felt. In relation to my study, Grade 8 students also demonstrated engagement in learning by responding to their classmates, using emojis and hashtags in their tweets, and collaborating on homework and group assignments. In another study, Junco et al. (2012) examined the use of Twitter in a pre-health professional seminar course, particularly in relation to assessing student collaboration, engagement, and success. They found that Twitter use encourages students and the instructor to interact on a regular basis, which was also true for Grade 8 students in this study. Ms. Miller assumed a more active role by posing probing questions to students and answering their questions when they encountered difficulties. In a related study, Tanner et al. investigated the use of Twitter as an instructional tool in a college algebra class and found that learning was positively impacted because of student-teacher and student-student interactions. Tanner et al. also found that students in this college algebra course began to answer each other's questions, which was also true for the Grade 8 students in this study. The dynamics of the classroom in both studies were changed, which encouraged students to assume the role of the teacher. Jacquemin (2014) conducted a study in which Twitter was incorporated into a higher education biology classroom and found that even though the majority of students believed that Twitter gave them access to important information about biology, they did not consider Twitter a valuable tool for learning. However, in my study, Grade 8 students engaged in discussions and sharing of resources, such as videos and visuals, on a regular basis in order to improve their learning of data management concepts.

Conceptual Framework

The key finding for this study is that social presence on Twitter had a positive impact on student engagement and learning. The quality of interactions among students and between students and the teacher indicated that Twitter had a high degree of social presence; in other words Twitter can be a warm, friendly, and personable place for learning mathematics. In interpreting the findings related to the central research question about the impact of Twitter on student learning and engagement, the definition of social presence from the conceptual framework needs to be considered. Short et al. (1976) defined social presence as "the degree of salience (i.e., quality or state of being there) of the other person in a mediated communication and the consequent salience of their interpersonal interactions" (p. 65). The term social presence refers to the quality of being present when two individuals are corresponding through a communication medium. Twitter is an example of computer-mediated communication, which is associated with social presence theory. Conrad and Poole (1998) defined communication as "the process by which people interactively create, sustain, and manage meaning"; therefore, Twitter is an example of computer-mediated communication because it allows users to post their responses, feedback, and opinions. A communication medium that has high social presence, such as a Skype conversation, is considered warm and personable while a communication medium that has low social presence, such as a podcast, is considered to be distant and unfriendly. Therefore, communication mediums are different in terms of their level of social presence, and consequently, the quality of interaction that occurs using these communication mediums is also different (Short et al., 1976). Due to the

quality of interactions among students and between students and the teacher, the finding of this study is that Twitter has a high degree of social presence, indicating that Twitter can be a warm, friendly, and personable medium for engagement and learning.

Results from this study indicated that all three components of social presence theory (i.e., affective, interactive, and cohesive) that Rourke, Anderson, Garrison, and Archer (1999) defined were present. The affective component includes use of emotions and emojis, use of humor, or self-disclosure. Student and teacher tweets consisted of several emojis, which included "smiling face" (😄), "grinning face" (😁), "smiling face with horns" (😈), "dizzy face" (😵), "face with mouth wide open" (😮), "face screaming in fear" (😱), "smiling face with smiling eyes" (😊), "smiling face with tears of joy" (😂), "sleepy face" (😪), "face with tongue stuck out" (😛), "worried face" (😟), "yummy face" (😋), "folded hands" (🙏), "bar chart" (📊), "pencil" (✏️), "smiling face with sweat (😅), "pineapple" (🍍), and "thumbs up" (👍). All six students and the teacher used these emojis to express their feelings about the instructional activities related to the data management unit. In addition to emojis, the teacher and students used numerous hashtags, such as #math, #mean, #centraltendency, #average, #homework, #kidblog, #respect, #graphing, #piegraph, #newassignment, #groupwork, #funwork, #learning, #Igetit, #bias, #mathisfun, #brainstorm, #showmethemath, #misleading, #lookclose, #whatswrong, #whereisbias. Students also posted a number of visuals and videos on Twitter to support their learning and engage their classmates. For example, they posted pictures of daily lessons that the teacher delivered, the work they completed in class, and their assignments, as well as posting videos on topics related to data management such as

media use of different graphs, central tendency, and misleading graphs to support their learning. They also showcased humor through tweets as well. Self-disclosure was evident when students tweeted about their personal preferences (e.g., favorite food, sports, and subjects) as well as their opinions about the instructional lessons and the assessments they completed in the form of quizzes, tests, and assignments.

The interactive component of social presence theory includes quoting other students' messages, explicitly acknowledging the messages of others, asking questions, complimenting and expressing appreciation, and communicating agreement. Students quoted each other's messages through the "retweet" feature of Twitter. When a user "retweets" a person's original tweet, that tweet is shared with all the followers of the person who "retweeted" the original tweet. Explicitly acknowledging the message of others was evident when students responded to each other's tweets and interacted with one another. These messages were evident in their responses to each other's questions related to homework, assignments, and dates for quizzes and tests. Asking questions allowed students to obtain the help they needed in order to clarify their understanding of data management concepts. Responding to each other's tweets also included extending each other's learning because classmates offered alternate explanations to word problems, communicating agreement with their peers about correct answers to word problems, and reflecting on their learning when the teacher and classmates asked probing questions. These responses often led to a continuous thread of tweets with more than two students participating, resulting in an online conversation where students were working and learning together. Students also complimented each other on their thoughts, ideas and

feedback in relation to the problem solving questions. Their appreciation for each other was also evident when they conveyed their thanks for the help they received from the teacher and their classmates. Students also expressed appreciation for the different ways in which their classmates solved word problems that the teacher posed. Students believed examining the different methods that their classmates used to solve word problems gave them different perspectives about problem solving.

The cohesive component of social presence theory refers to the use of vocatives, referring to the group use of inclusive pronouns and salutations. This component was apparent when students responded to each other's tweets. The use of "you", "we", and first names was quite prominent in many of their tweets. Therefore, all three components of social presence theory were present in this study, indicating that social presence had a positive impact on student engagement and learning in a Grade 8 mathematics classroom.

Limitations of the Study

Limitations of a study are often the result of the research design. The first limitation is related to the single case. Yin (2014) contended that a single case does not allow for theoretical replication, only limited literal replication. Theoretical replication is not possible in a single case study because one case does not allow for contrasting results to be found. A single case study allows for some degree of literal replication because the singe case study can be replicated in a similar setting to corroborate results. Therefore, limited transferability is possible with a single case design; however, a multiple-case study design reinforces transferability (Yin, 2014).

The second limitation is related to the participant sample. The participants in this study included one classroom teacher and six students in a Grade 8 mathematics course. This small sample size may not be indicative of Twitter's impact on students' engagement and learning; therefore, interviews with more students and teachers would have provided richer data on student engagement and learning in relation to data management concepts.

The third limitation is related to the data collection process. The instructional unit on data management consisted of 4 weeks, and data collection consisted of 8 weeks, which occurred close to the end of the school year. Therefore, data collection may not reflect the full extent of student experiences in using Twitter to solve word problems in a year-long Grade 8 mathematics course. Furthermore, students and the teacher were interviewed only once; multiple interviews over a longer period of time could have yielded additional data.

Recommendations for Future Research

Recommendations for future research are based on the strengths, limitations, and the literature review for this study. The first recommendation is to replicate this study over a longer period of time and include more instructional units. The data management unit was only 4 weeks long, which might not be representative of students' experiences with using Twitter. In a study about student communication experiences with Twitter, Gunuc (2013) found that students did not find Twitter useful for communication during a 2 week period of time, yet in this 4 week study, positive results were found in terms of student engagement and learning. Conducting a similar study in which the instructional unit is longer than 4 weeks or exploring the use of Twitter in a mathematics classroom

during two or more instructional units might be beneficial in terms of capturing additional data on students' experiences with using this social media tool for engagement and learning.

The second recommendation is to replicate this study in low socioeconomic status schools in order to determine if the findings would be similar. This study was conducted in a mid-level to high-level socioeconomic status school where most students had their own device or had easy access to technology. However, in low socioeconomic schools, not all students have access to a device in order to use applications such as Twitter for learning purposes. Therefore, in order to replicate this study at these schools, students would first need equal access to a device in order to utilize applications such as Twitter for learning purposes.

The third recommendation is to replicate this study at a different time of the school year. This study was conducted near the end of the school year, and during this time, students were completing their final projects and assignments, taking final tests, preparing for graduation, and looking forward to their summer holidays. These factors could have impacted the results of this study. Therefore, conducting this study either at the start of the year or halfway through the school year might determine the full impact of Twitter use on student engagement and learning in mathematics.

The fourth recommendation is to conduct a study in which students focus on their metacognitive skills when using Twitter. The results of this study demonstrated that students reflected on their learning because they reported where they experienced difficulties understanding data management concepts. Students also reflected on the

different ways their classmates solved mathematical word problems. Therefore, conducting a study in which the purpose is to investigate the impact of student self-reflection and self-assessment about Twitter use on student learning may be beneficial.

The fifth recommendation is to explore the impact of Twitter use in building a positive community and climate in the classroom. The results of this study indicated that the teacher and students believed classroom community and climate were positively enhanced due to the use of Twitter. Students reported that they interacted with classmates who they usually did not talk to in the classroom. Therefore, conducting a study to investigate whether or not interactions on Twitter enhance face-to-face interactions among students and positively impact classroom community and climate would be valuable.

Implications for Social Change

This study will make several contributions to positive social change. The first contribution is advancing knowledge about the role of educational technology in the improvement of student learning. Twitter provides a platform for all students, regardless of their ability or achievement level, to be active participants in their learning. In the classroom, many students are not comfortable sharing their opinions and knowledge; often only a handful of students actively participate in class, and teachers often have difficulties improving participation for quiet students. However, the use of Twitter encourages these students to have a voice and to share their ideas and knowledge about concepts they have learned in class. Twitter provides the opportunity for all voices to be heard and for students to learn about the different perspectives and experiences of all of

their classmates. This study also advances knowledge in relation to the use of specific educational technology for instruction, such as blogs, wikis, Google apps, Google Classroom, YouTube, and iPads. Although many of these tools support some form of interaction between students, Twitter provides opportunities for all students in a class to interact with each other, creating a more effective network of learners. Twitter also gives students access to experts in the field so that students can ask them questions to improve their understanding of skills and concepts. These types of interactions also help students build professional learning networks at the local, provincial, and global levels. In this study, students were provided with numerous opportunities to interact with mathematics experts under the teacher's guidance. Therefore, Twitter is an educational technology tool that teachers can incorporate into their instruction in order to improve teaching and learning.

The second contribution of this study to positive social change is improved practice in mathematics education. Twitter use encourages students to learn concepts beyond the four walls of the classroom. Students can interact with each other and their teacher by asking questions and receiving timely feedback in order to clarify their understanding of challenging mathematical concepts. Students can also work collaboratively on group projects to solidify their understanding of these concepts. Although this study did not use quantitative methods to examine Twitter use, it did demonstrate that students are engaged in their learning because they have access to a platform that encourages them to ask for assistance and to synthesize their learning in a timely fashion. In this way, students not only begin to form relationships that would not

have otherwise been possible, but they are also empowered to take control of their learning.

The third contribution of this study is to positive societal change. Twitter use encourages students to form a network of learners. Building a community of learners encourages students not only to learn from each other but from Twitter itself. For example, students can use hashtags related to their subject area in order to deepen their understanding about challenging concepts. Searching a topic by its hashtag allows students to view tweets from experts in the field without having to follow them on Twitter or respond to their tweets. However, if executed with teacher guidance, students can follow experts in a particular discipline and engage in conversations with them in order to increase their understanding of the subject matter. This community of learners extends beyond the students in the classroom to members of society who benefit from becoming mentors and role models for these students and from building on and extending this collective knowledge in order to improve their understanding of skills and concepts related to their discipline or career.

Conclusion

The purpose of this qualitative case study was to explore how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit. The results from this study add to the body of literature about how the integration of social media tools, such as Twitter, can be used to improve student engagement and learning in a middle school mathematics classroom. The findings also support further inquiry into how social presence can be

implemented to increase student engagement and learning. Although the results of this study indicated a positive impact of the use of Twitter on student engagement and learning, this study was limited to one school with a relatively small sample of students, and therefore, the findings may be transferable only to similar populations and similar settings. Existing studies also demonstrate that the use of Twitter has the ability to engage learners and positively impact their learning; therefore, the results from this study indicate that Twitter use needs to be explored in future research to ensure that students are given opportunities to engage more deeply in their learning.

This study provides additional evidence on the importance of using social media platforms like Twitter in the classroom to increase engagement and learning. Twitter has the ability to change student attitudes toward learning mathematics because students find their voices through the use of this social media platform, which encourages increased interactions, conversations, and collaboration. Technology has been a central focus in education, and it is essential that educators leverage and incorporate technology tools that students use on a personal and social level into classroom instruction so that students can form connections and build classroom communities that improve their engagement and learning in all subject areas.

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Appendix A: District Letter of Cooperation

Shelly Vohra
May, 2015

Dear Ms. Vohra,

Based on my review of your research proposal, I give permission for you to conduct the study titled *How Social Presence on Twitter Impacts Student Engagement and Learning in a Grade 8 Mathematics Classroom* in this District School Board**.** As part of this study, I authorize you to (a) select a Grade 8 mathematics teacher and six Grade 8 students from that class as participants, (b) collect data from interviews, online reflective journals, student artifacts, and documents, and (c) disseminate the results of the study by mailing a summary of the results to the participants and the school principal and offering an after school presentation to parents, teachers, and administrators if they are interested. Individuals' participation will be voluntary and at their own discretion.

We understand that our organization's responsibilities include access to an office conference room with a door that can be closed for privacy purposes. We reserve the right to withdraw from the study at any time if our circumstances change.

The teacher and students will be responsible for complying with our site's research policies and requirements.

I confirm that I am authorized to approve research in this setting and that this proposal complies with our organization's policies.

I understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the student's supervising faculty/staff without permission from the Walden University IRB.

Sincerely,

Chief Research Officer

Appendix B: School Letter of Cooperation

Shelly Vohra
May, 2015

Dear Ms. Vohra,

Based on my review of your research proposal, I give permission for you to conduct the study entitled *How Social Presence on Twitter Impacts Student Engagement and Learning in a Grade 8 Mathematics Classroom* at this middle school**.** As part of this study, I authorize you to (a) select a Grade 8 mathematics teacher and six Grade 8 students from that class as participants, (b) collect data from semi-structured interviews, online reflective journals, student artifacts, and documents, and (c) disseminate the results of the study by mailing a summary of the results to participants and the school principal and offering an after school presentation to parents, teachers, and administrators if they are interested. Individuals' participation will be voluntary and at their own discretion.

We understand that our organization's responsibilities include access to an office conference room with a door that can be closed for privacy purposes. We reserve the right to withdraw from the study at any time if our circumstances change.

The student will be responsible for complying with our site's research policies and requirements.

I confirm that I am authorized to approve research in this setting and that this proposal complies with our organization's policies.

I understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the student's supervising faculty/staff without permission from the Walden University IRB.

Sincerely,

Principal

Appendix C: Teacher Letter of Invitation

May, 2015

Dear Teacher,

My name is Shelly Vohra, and I am a doctoral candidate in educational technology at Walden University. I am conducting a research study as part of the requirements of my degree in educational technology, and I would like to invite you to participate in this study.

I am studying how social presence on Twitter impacts student engagement and learning when this technology tool is integrated into their mathematics classroom. To accomplish this purpose, I will describe how a teacher uses Twitter to help students improve their learning in mathematics. In addition, I will also describe how the teacher and students perceive the value of using Twitter to improve learning in mathematics. I will also describe how artifacts such as tweets and problem solving notebooks support student learning in mathematics.

I am inviting you to participate in this research because you currently teach a Grade 8 mathematics course that includes the use of Twitter.

Please read the enclosed teacher consent form carefully because the procedures for participation are explained. If you have any questions about this study, you may contact me at shelly.vohra@waldenu.edu.

If you would like to participate in this study, please sign the enclosed teacher consent form and return it to me in the self-addressed stamped envelope within the next two weeks. I will select the first teacher who returns the signed consent form to me.

With kind regards,

Shelly Vohra
Walden University
shelly.vohra@waldenu.edu

Appendix D: Teacher Consent Form

You are invited to participate in a research study about how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into instructional units. The researcher is inviting all Grade 8 mathematics teachers in this school district to participate in this study who currently are using Twitter as an instructional tool in their classrooms. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether or not to participate in it.

This study is being conducted by a researcher named Shelly Vohra, who is a doctoral student at Walden University.

Please note that I will select the first teacher who signs and returns this consent form to me in the enclosed self-addressed stamped envelope.

Background Information:

The purpose of this study is to explore how social presence on Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit.

Procedures:

If you agree to be in this study, you will be asked to:

- Maintain an online journal in the form of a blog (kidblog.org) by answering three questions that are one paragraph in length
- Participate in one 30-minute interview at the end of the study in which I will ask you about your experiences using Twitter to help students improve their learning in mathematics. The interview will be conducted during non-instructional hours before or after school

The total time commitment for your participation in this study is the length of the instructional unit, which is 4 weeks.

Here are some sample interview questions:

1. Tell me about your experiences in using Twitter to engage students in learning data management concepts and skills?
2. What is your opinion about using Twitter to improve student learning in the mathematics classroom in relation to data management concepts and skills?

3. How do you believe your role as a teacher has changed due to your use of Twitter in the mathematics classroom?

Here are some sample reflective journal questions:

1. How frequently did you post tweets? How would you describe the content of those tweets?
2. How do you believe students were engaged on Twitter to enhance their learning about data management concepts and skills?

Voluntary Nature of the Study:

This study is voluntary. Everyone will respect your decision about whether or not you choose to participate in this study. No one in this school district will treat you differently if you decide not to participate in this study. If you decide to join the study now, you can still change your mind later. You may stop at any time.

Risks and Benefits of Participating in this Study:

You may find some of the questions challenging to answer. However, participating in this study will not pose risk to your safety or wellbeing.

This study will also benefit teachers in this district in several ways. I plan to discuss the results of this study with the Grade 8 mathematics teachers and the principal of the school. I also plan to conduct professional development workshops so that classroom teachers can learn how to use Twitter to improve student engagement and learning in math and other subject areas.

Payment:

No compensation will be provided for your participation in this study.

Privacy:

Any information you provide will be kept confidential. I will not use your personal information for any purposes outside of this research study. In addition, I will not include your name or anything else that could identify you in the study reports.

I will also keep your responses to the interviews and reflective journals confidential.

In addition, I will use pseudonyms for the school district, the school, and the students to protect their identities.

I will store all data on my personal, password-protected computer located in a locked file cabinet in my home, which includes data from the interview, the tweets from Twitter, and the online reflection blogs written on kidblog.org. I will keep data from this study for a period of 5 years, as required by Walden University.

Contacts and Questions:

If you have any questions about this study, you may contact me at shelly.vohra@waldenu.edu. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott who is the Walden University representative who can discuss your questions with you. Her phone number is 1-800-925-3368, extension 1210.

I have enclosed an extra copy of this consent form for your records.

Statement of Consent:

I have read the above information and I feel I understand the study well enough to make a decision about my involvement. By signing below, I understand that I am agreeing to the terms described above.

Printed Name of Participant _____

Date of Consent _____

Participant's Signature _____

Researcher's Signature _____

Appendix E: Parent and Student Letter of Invitation

May, 2015

Dear Parents/Guardians and Student,

My name is Shelly Vohra, and I am a doctoral candidate in educational technology at Walden University, an accredited institution of higher learning. I am conducting a research study as part of the requirements for my degree in educational technology.

The purpose of this study is to describe how Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit.

I am inviting your child to participate in this research because he or she is enrolled in a Grade 8 mathematics class in which the teacher has integrated Twitter into instructional units.

Please read the enclosed parent consent form and student assent form carefully because the procedures for participation are explained. If you have any questions about this study, you may contact me at shelly.vohra@waldenu.edu.

If you would like your child to participate in this study, please sign the enclosed parent consent form. If your child is interested in participating in this study, please ask him or her to sign the enclosed assent form. Please return both forms to me in the enclosed self-addressed stamped envelope within the next two weeks. I will select the first six students who return both the signed consent and assent forms to me.

With kind regards,

Shelly Vohra
Walden University
shelly.vohra@waldenu.edu

Appendix F: Parent/Guardian Consent Form

Hello,

My name is Shelly Vohra, and your child is invited to take part in a research study about how using Twitter in the Grade 8 mathematics classroom impacts their engagement and learning. I am inviting all students enrolled in this Grade 8 mathematics classroom to participate in this study. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether or not to allow your child to participate.

This study is being conducted by a researcher named Shelly Vohra, who is a doctoral student at Walden University.

Please note that I will select the first six students to participate in this study who return both their signed parent/guardian consent and student assent forms to me.

Background Information:

The purpose of this study is to explore how Twitter impacts student engagement and learning when a mathematics teacher integrates this social media tool into an instructional unit.

Procedures:

If you agree to allow your child to participate in this study, your child will be asked to:

- maintain an online journal in the form of a blog (kidblog.org) by answering three questions that are one paragraph in length
- participate in a 30-minute individual interview at the end of the study in which I will ask your child about his or her experiences using Twitter to improve learning in mathematics. The interview will be conducted during non-instructional hours either before or after school

The total time commitment for your child's participation in this study is the length of the instructional unit, which is 4 weeks.

Here are some sample interview questions:

1. Tell me about your experiences in using Twitter to help you solve word problems in mathematics related to data management?

2. What is your opinion about using Twitter to help you to understand data management concepts and skills?
3. How do you believe your learning has changed when you used Twitter to learn data management concepts and skills?

Here are some sample reflective journal questions:

1. Describe the content of your tweets this week.
2. Describe the content of your responses to your classmates' tweets.

Voluntary Nature of the Study:

This study is voluntary. Everyone will respect your decision about whether or not you want your child to participate in this study. Of course, your child's decision is also an important factor. No one at Lisgar Middle School will treat you or your child differently if you or your child decides to not participate in this study. If you decide to give your consent now, you or your child can still change your decisions later.

Risks and Benefits of Participating in this Study:

Your child may find some of the questions challenging to answer. However, participating in this study will not pose risk to your child's safety or wellbeing.

This study may benefit your child in several ways. Your child may develop a better understanding of how Twitter can be used to learn mathematics. Your child will also have an opportunity to use Twitter to consider its impact on his or her motivation to learn mathematics.

Payment:

No compensation will be provided for your child's participation in this study.

Privacy:

Any information your child provides will be kept confidential. I will not use your child's information for any purposes outside of this research study. In addition, I will not include your child's name or anything else that could identify your child in any reports of this study. The only time I would need to share your child's name or information would be if I learn about possible harm to your child or someone else.

In addition, I will use pseudonyms for the school district, the school, and the students to protect their identities.

I will store all data on my personal, password-protected computer located in a locked file cabinet in my home, which includes data from the interview, the tweets from Twitter, and the online reflection blogs written on kidblog.org. I will keep data from this study for a period of 5 years, as required by Walden University**.**

Contacts and Questions:

If you have any questions about this study, you man contact me at shelly.vohra@waldenu.edu. If you want to talk privately about your child's rights as a participant, you can call Dr. Leilani Endicott who is a Walden University staff member who can discuss your questions with you. Her phone number is 1-800-925-3368, extension 1210.

I have enclosed an extra copy of this consent form for your records.

Statement of Consent:

I have read the above information and I feel I understand the study well enough to make a decision about my child's involvement this optional research project. By signing below, I understand that I am agreeing to the terms described above.

Printed Name of Parent	
Printed Name of Child	
Date of consent	
Parent's Signature	
Researcher's Signature	

Appendix G: Student Assent Form

Hello,

My name is Shelly Vohra, and I am conducting a research study about how Twitter impacts student engagement and learning when a Grade 8 mathematics teacher integrates this social media tool into an instructional unit. I am inviting you to participate in this study because you are enrolled in a Grade 8 mathematics course at this middle school in which Twitter is used. However, I will select only the first six students whose parents/guardians return signed consent and assent forms to me in the enclosed self-addressed stamped envelope.

WHO I AM:

I am a student at Walden University. I am working on my doctoral degree.

ABOUT THIS STUDY:

If you agree to participate in this study, you will be asked to:

- Maintain an online journal in the form of a blog (kidblog.org) by answering three questions about your Twitter use that are one paragraph in length
- Give me your mathematics notebooks once a week so that I can review how you are learning mathematics
- Participate in a 30-minute individual interview in which I will ask you about your experiences using Twitter to help you learn mathematics

Your total time commitment for participation in this study is the length of the instructional unit, which is 4 weeks.

Here are some sample interview questions:

1. Tell me about your experiences in using Twitter to help you solve word problems in mathematics related to data management?
2. What is your opinion about using Twitter to help you understand data management concepts and skills?
3. How do you believe your learning has changed when you used Twitter to learn data management concepts and skills?

Here are some sample reflective journal questions:

1. Describe the content of your tweets this week.
2. Describe the content of your responses to your classmates' tweets.

IT'S YOUR CHOICE:

You don't have to participate in this study if you don't want to. If you decide now that you want to join this study, you can still change your mind later. If you want to stop, you can.

You many find some of these questions challenging to answer. However, you may also develop a better understanding of how Twitter might be used to help you learn mathematics.

PAYMENT:

No compensation will be provided for your participation in this study.

PRIVACY:

Everything you tell me during this study will be kept private. That means that no one else will know your name or what responses you give. If I learn about something that could hurt you or someone else, I will need to inform my faculty advisor.

I will store all data on my personal, password-protected computer located in a locked file cabinet in my home, which includes data from the interview, the tweets from Twitter, and the online reflection blogs written on kidblog.org. In addition, your name and the name of the school and the school district will not be used. Instead, pseudonyms will be used to protect your identity.

ASKING QUESTIONS:

If you want to ask questions about this study, you or your parents/guardians can reach me at shelly.vohra@waldenu.edu or you can call Dr. Leilani Endicott at Walden University. Her phone number is 1-800-925-3368, extension 1210.

I have enclosed an extra copy of this consent form for your records.

Please sign your name below if you want to participate in this study.

Name of Child _____

Child's Signature _____

Date _____

Researcher's Signature _____

Appendix H: Student and Teacher Interview Questions

Student Questions

1) Tell me about your experiences in using Twitter to help you solve word problems in mathematics related to data management.

2) What is your opinion about using Twitter to help you to understand data management concepts and skills?

3) How did you work with your classmates on Twitter to learn about data management concepts and skills?

4) How do you believe your learning has changed when you used Twitter to learn data management concepts and skills?

5) What benefits did you experience in using Twitter to solve word problems related to data management?

6) What challenges did you experience in using Twitter to help you solve word problems related to data management?

7) What ideas do you have for other students about using Twitter to learn other mathematical concepts such as integers, fractions, and algebra?

8) What ideas do you have for teachers about how to use Twitter to help students learn other mathematical concepts such as integers, fractions, and algebra?

Teacher Questions

1) Tell me about your experiences using Twitter to engage students in learning data management concepts and skills?

2) What is your opinion about using Twitter to improve student learning in relation to data management concepts and skills?

3) How do you believe your role as a teacher has changed due to using Twitter in your mathematics classroom?

4) What benefits do you believe students receive when they use Twitter to learn mathematical concepts and skills?

5) What challenges do you believe students face in using Twitter to engage to learn mathematical concepts and skills?

6) What suggestions do you have about how to engage students on Twitter in order to enhance their learning of mathematical concepts and skills?

Appendix I: Student and Teacher Reflective Journal Questions

Student Questions

1) Describe the content of your tweets this week.

2) Describe the content of your responses to your classmates' tweets.

3) Why did you choose to respond to some classmates and not to others in relation to solving word problems?

Teacher Questions

1) How frequently did you post tweets? How would you describe the content of those tweets?

2) How frequently did you engage with students during the instructional unit on data management? How would you describe the nature of these interactions? Were some interactions not related to this unit? If so, how would you categorize the nature of these interactions?

3) How do you believe students were engaged on Twitter to enhance their learning about data management concepts and skills?

Appendix J: Alignment of Research Questions to Interview and Reflective Journal Questions

Central Research Question: How does social presence on Twitter impact student engagement and learning when a mathematics teacher integrates this social media tool into mathematics instruction?

Student Interview Questions

1) Tell me about your experiences in using Twitter to help you solve word problems in mathematics related to data management?

2) What is your opinion about using Twitter to help you to understand data management concepts and skills?

3) How do you work with your classmates on Twitter to learn about data management concepts and skills?

4) How do you believe your learning has changed when you used Twitter to learn data management concepts and skills?

5) What benefits did you experience in using Twitter to solve word problems related to data management concepts and skills?

6) What challenges did you experience in using Twitter to solve word problems related to data management concepts and skills?

7) What ideas do you have for other students about using Twitter to learn other mathematical concepts such as integers, fractions, and algebra?

8) What ideas do you have for teachers about using Twitter to help students learn other mathematical concepts such as integers, fractions, and algebra?

Teacher Interview Questions

1) Tell me about your experiences using Twitter to engage students in learning data management concepts and skills?

2) What is your opinion about using Twitter to improve student learning in relation to data management concepts and skills?

3) How do you believe your role as a teacher has changed due to using Twitter in your mathematics classroom?

4) What benefits do you believe students receive when they use Twitter to learn mathematical concepts and skills?

5) What challenges do you believe students face in using Twitter to engage to learn mathematical concepts and skills?

6) What suggestions do you have about how to engage students on Twitter in order to enhance their learning of mathematical concepts and skills?

Student Reflective Journal Questions

1) Describe the content of your tweets this week?

2) Describe the content of your responses to your classmates' tweets.

3) Why did you choose to respond to some classmates and not to others in relation to solving word problems?

Teacher Reflective Journal Questions

1) How frequently did you post tweets? How would you describe the content of those tweets?

2) How frequently did you engage with students during the instructional unit on data management? How would you describe the nature of these interactions? Were some interactions not related to this unit? If so, how would you categorize the nature of these interactions?

3) How do you believe students were engaged on Twitter to enhance their learning about data management concepts and skills?

Related Research Question #1: How does a teacher use Twitter to help students improve their learning in mathematics?

Teacher Interview Questions

3) How do you believe your role as a teacher has changed due to using Twitter in your mathematics classroom?

6) What suggestions do you have about how to engage students on Twitter in order to enhance their learning of mathematical concepts and skills?

Teacher Reflective Journal Questions

1) How frequently did you post tweets? How would you describe the content of those tweets?

2) How frequently did you engage with students during the instructional unit on data management? How would you describe the nature of these interactions? Were some interactions not related to this unit? If so, how would you categorize the nature of these interactions?

Related Research Question #2: How does a teacher perceive the value of students using Twitter to improve their learning in mathematics?

Teacher Interview Questions

1) Tell me about your experiences using Twitter to engage students in learning data management concepts and skills.

2) What is your opinion about using Twitter to improve student learning in relation to data management concepts and skills?

4) What benefits do you believe students receive when they use Twitter to learn mathematical concepts and skills?

5) What challenges do you believe students face in using Twitter to engage to learn mathematical concepts and skills?

Teacher Reflective Journal Questions

2) How frequently did you engage with students during the instructional unit on data management? How would you describe the nature of these interactions? Were some interactions not related to this unit? If so, how would you categorize the nature of these interactions?

3) How do you believe students were engaged on Twitter to enhance their learning about data management concepts and skills?

Related Research Question #3: How do students perceive the value of using Twitter to improve their learning in mathematics?

Student Interview Questions

1) Tell me about your experiences in using Twitter to help you solve word problems in mathematics related to data management?

2) What is your opinion about using Twitter to help you understand data management concepts and skills?

3) How do you work with your classmates on Twitter to learn about data management concepts and skills?

4) How do you believe your learning has changed when you used Twitter to learn data management concepts and skills?

5) What benefits did you experience in using Twitter to solve word problems related to data management concepts and skills?

6) What challenges did you experience in using Twitter to help you solve word problems related to data management concepts and skills?

7) What ideas do you have for other students about using Twitter to learn other mathematical concepts such as integers, fractions, and algebra?

8) What ideas do you have for teachers about using Twitter to help students learn other mathematical concepts such as integers, fractions, and algebra?

Student Reflective Journal Questions

1) Describe the content of your tweets this week.

2) Describe the content of your responses to your classmates' tweets.

3) Why did you choose to respond to some classmates and not to others in relation to solving word problems?

Related Research Question #4: How do artifacts such as tweets and problem solving notebooks support student learning in mathematics?

Student Interview Questions

1) Tell me about your experiences in using Twitter to help you solve word problems in mathematics related to data management?

3) How do you work with your classmates on Twitter to learn about data management concepts ands skills?

4) How do you believe your learning has changed when you used Twitter to learn data management concepts and skills?

5) What benefits did you experience in using Twitter to solve word problems related to data management?

Student Reflective Journal Questions

2) Describe the content of your responses to your classmates' tweets?

3) Why did you choose to respond to some classmates and not to others in relation to solving word problems?