Monitoring and Assessing Student Thinking in Google Math Classroom Environments

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Abstract
Monitoring and assessing student thinking, facilitating mathematical processes and increasing student engagement are key issues for practicing elementary mathematics teachers. Awareness of student thinking allows teachers to plan lessons according to zones of proximal development and pace teaching, and group members accordingly. Awareness also allows teachers to catch misconceptions early. This article examines the use of Google Classroom to facilitate the mathematical processes of communication, representation, reasoning and justification or proof, allowing arguments to be built on prior knowledge that is accessible and readily available and noting the particular benefit for students of age 10-12 who benefit from shared awareness and subsequent student calibration when sharing their thinking at this age.

Keywords: *Accountability; Shared Awareness; Collaborative Group Settings; Engagement; Privacy Protection; Equity*

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1. Introduction

This article examines the ways in which Google Classroom can be of use to mathematics teachers of students aged 10-12 years. Google Classroom was selected as a tool for communicating thinking in mathematics because of its equitable nature as it affords students the opportunity to participate outside of school hours, and with the influence of family and friends. Google Classroom is also accessible to students with special needs or English Language learners because of the ease of accessibility and the accordance of additional time, or front loading some students require as accommodations. Finally, Google Classroom offers teachers the ability to monitor and assess student thinking, while allowing students to share thinking with others to provide evidence of the mathematical processes, cognition and metacognition. Sharing thinking with others is a requirement of developing mathematical discourse and the mathematical processes.

Beginning in 2018, the Social Sciences and Humanities Research Council (SSHRC) identified interest in considering how emerging technologies can be leveraged to benefit Canadians. Prepandemic communication and collaborative technologies in elementary mathematics were met with controversy for proponents of more hands on pedagogical approaches that encouraged students to create and hold 3-D shapes and citing both physical and psychological detrimental effects for students use of technology for extended periods of time. As such, the use of technology is seen as a benefit for teachers and students when it is purposely designed and limited in its use or dependency for learning. Research on Google Classroom dates back to its release in August 2014 (Kahn, 2014; Lapowsky, 2014) in subject areas of Science (Smith &Mader, 2015). For the most part, Google Classroom has been seen as a way to deliver information to parents (Sadownik, 2018) and rarely as a tool to promote mathematics processes (Sadownik, 2017; 2018).

2. Background

From a communication perspective, Google Classroom affords teachers the ability to engage in two-way communication, to post multi-media content and is accessible through most web browsers. In January 2015 it became possible to use Android and iOS mobile applications. The initial requirement of users was a Gmail account provided by educational institutions. This feature allowed many school districts to monitor student communication behind a firewall of protection provided by the district.

Prepandemic there was limited parent interaction and observation of the class. Some parents, who requested access, were invited to use their child's account, with their child's permission and password to gain access if they were interested in viewing the material. In March 2017, Google Classroom allowed personal users to join classes without the requirement of an education account (Ressler, 2017) and in April 2017 it became possible for anyone to create and teach a class (Etherington, 2017; Regan, 2017). Postpandemic, many parents, educators, and students have grown in their use and knowledge of Google Classroom as an online course delivery system and portal for accessing and uploading assignments.

2. Theoretical Framework

Google Classrooms used by educational institutions fall under the technology agreement (Sadownik, 2022a) and as such are monitored and capable of tracking student behaviour, despite assurances that school districts do not engage in active monitoring (Sadownik, 2022a). Educators are expected to monitor and report inappropriate behaviour, reporting inappropriate behaviour to administrators and students and staff are expected to use technology (i.e. Google Classroom) in an appropriate manner during school hours regardless of the ownership of the device or location (Sadownik, 2022a). The use of Google Classroom has raised concerns with parents for tracking student information (Sadownik, 2022a) and raised issues related to demanded anonymity of students by parents for educators and IT Staff (Sadownik, 2022a). It is difficult for an educator to monitor and report inappropriate behaviour if the student cannot be identified and furthermore it detracts from the required community sociomathematical norms necessary for building knowledge and developing mathematical processes (Sadownik, 2018).

Although punitive monitoring of private online communication is not encouraged by Courts in the United States (Huth, 2013) or the Criminal Code in Canada (Section 319(2) C-46) which stipulates private communication is viewed differently than public; from an equitable standpoint vulnerable and marginalized populations may not feel encouraged to have voice or agency in schools about lived experiences or difficulties with mental well-being in the forms of emotion dysregulation, or specifically a Disruptive Mood Dysregulation Disorder (DMDD) as noted in the American Psychiatric Association (APA) Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Many school districts do not have accommodations in place for vulnerable and marginalized populations under the technology agreement other than the provision of devices for students in lower socio economic classes or with identified special needs (Sadownik, 2022b). For many mathematics teachers using Google Classroom and monitoring school owned and student owned devices can be problematic under their current technology agreement without addressing parent concerns about protection of privacy and purpose for the collection of data (Sadownik, 2022a).

The collection of data and the protection of privacy has been heralded by human rights agencies and government watchdogs that support court rulings in Canada, however as of 2020 academics have noted potential human rights violations that may have gone undetected (Agrawal, 2021; Joly & Wheaton 2020; Lamarche, 2020; McBride et al., 2020; Mykhalovskiy et al., 2020; Robertson, et al., 2020; Tisdale & Symenuk, 2020; Torelli, 2020; World Health Organization, 2020). Furthermore, the use of devices to engage with other students or staff is restricted to the definitions listed in policy documents and legal expectations for appropriate use (Sadownik, 2022; Hills, 2018; MacKenzie, 2016; Maxwell, 2018). Previous research conducted on the use of BYOD for teacher and student laptops and mobile phones, teacher professional development with BYOD and the potential surveillance of teachers and students while on these personal devices on school property was also reviewed (Berg, 2015; Fuller, 2019; Goodyear et al., 2019; Hope, 2016; Monahan, 2006; Page, 2017; Perry-Hazan & Brinhack, 2018; Taylor, 2013)

Beginning in 2014, studies began to emerge considering how student owned devices could be used in the classroom. This initial consideration looked at the potential use of cellphones (Bruder, 2014; Imazeki, 2014) and the associated risks (Bruder, 2014). In 2015, a focus on university students (Pagram et al., 2015; Van Wingerden et al., 2015) became of interest and parental engagement (Kiger & Herro, 2015). Once again, security issues were also considered (Olalere et al., 2015). In 2016, two years after the initial onset of BYOD research, academics were focused on secondary students (Adhikari, & Parsons, 2016) and primary students (McLean, 2016), risks to health (Merga, 2016) and academic rigour (Dawson, 2016). Flipped classrooms (Hung, 2017), motivation (Castillo-Manzano et al., 2017; Hopkins et al., 2017; Laxman, & Holt, 2017) and distractions (Kay et al., 2017) were introduced in 2017 while parent engagement was revisited (Chan et al., 2017). Adding apps to BYOD appeared in 2018 (Song, & Wen, 2018) and finally teachers' experiences with 'always on' became of interest in 2019 (Murray et al., 2019).

It can be daunting for teachers given the current technology climate to use online tracking of student data and shared thinking despite the immeasurable benefits and innovations that it also supports (Sadownik, 2022a). It is therefore crucial for school administrator and educators to have a clear understanding of the purpose and intent of the design of activities on Google Classroom, identifying the benefits for students and parents, and acknowledging the concerns raised. The demand for teachers to integrate technology into their classrooms then have left some feeling vulnerable (Sadownik, 2022b). The additional dimension of facilitating mathematics discourse and shared thinking adds to this feeling of vulnerability and awareness of parent skepticism (Sadownik, 2018). Interestingly, many teachers perceive the use of technology to be for presentation and the integration of mathematics and technology to equate to playing games on the computer. A practice Joung & Byun (2021) posit should consider the extent to which the content aligns with the NCTM Content and Process standards, noting most focus on the development of Number and Operations.

The NCTM Agenda report lists curricular approaches as a key guiding question when linking research to practice and considers "in what ways different curricular approaches and/or combinations of those approaches support or impede students' development of mathematical proficiency?" (p.) This question intersected with a program and scope dimension (p.) suggests ways teachers may reflect on their curricular approaches to: teaching all strands; integrating strands,; mathematical processes; and using key ideas to make connections. But what does it mean to teach all of the strands from a curriculum perspective and from the perspective of developing mathematics proficiency? Chen et al., (2012) advocate collaborative and communicative technology's ability to record and allow users to access previous thinking. Scardamalia (2002) theorizes knowledge building communities are facilitated through the use of collaborative and communicative technologies. In this way the use of Google Classroom to promote discourse in mathematics, share thinking and facilitate mathematical processes teachers cognizant of privacy considerations and student tracking may support the development of student mathematical proficiency for ages 10-12.

A teacher's use of collaborative and communicative technologies does not automatically lead to success or improved achievement. Pifarre and Cobos (2010) point out assumptions exist that the presence of technology will automatically establish social interaction between users. This is not the case. Considerations related to how a teacher designs instruction with the aid of technology and student pairings dictates the level of social interaction among students. Barron (2003) concurs, noting it is the quality of the interactions that occur which are paramount to the success of the group. These reaffirms the need for teachers to be actively monitoring student thinking and encouraging students to share this thinking for the pacing of lessons and groupings of students in collaborative assignments.

3. Methodology

Research and data collection began in 2019, with four Canadian School Districts agreeing to participate in person and online regarding the monitoring of students online in response to an earlier study (Sadownik, 2018) noting the benefits to sharing thinking online in mathematics for students aged 10-12 years. Interviews took place on-site at school board offices, and online through videoconferencing, over the phone and through emails. Triangulation of data was achieved through teacher written response (list of questions), followed by teacher interview, and finally through external review. A case study approach was used to summarize the findings.

There are limitations to the present study. First, it should be acknowledged that the participants in the study were selected based on their technological background, and position within the participating school districts. Second, the sample size is a limitation. Socio-economic status (SES) is a third consideration in this study due to the technology provided to the schools, and the experience with technology students and parents or caregivers had in the home.

Data sources, evidence, objects or materials

Table 1. Demographic information collected from study participants

	Case Study # 1	Case Study # 2	Case Study # 3	Case Study # 4
Date	Jan 8.2020- Jan 10.2020	Oct 29.2019	Nov 1. 2019	Dec 13.2019
Location	Vancouver Island, BC	Vancouver Island, BC	Toronto, ON	Vancouver Island, BC
Size	8,000 students	11,300 students	247,000 students	14 700 students
Gender	Female: 1a, 1b, 1c, 1d	Male: 1a, 1b	Female: 1	Male: 1
Position	Teacher : 1a, 1b, 1c, Administrator : 1d	Head of Department : 1a Director (IT): 1b	Administrator : 1	Management (IT): 1

Interview transcripts were reviewed with an open-coding format, which facilitated the consideration of emergent patterns. The information collected set a framework for the literature and guided the direction of themes emerging from previous interviews, ones that aligned with the literature review as well as new ones that had yet to be mentioned. The combination of the data from the four case studies and literature review helped to refine and differentiate categories to explore that seem promising to develop. Axial coding is used to relate emergent patterns found in the case study data with literature review themes. These tables are provided at the end of this paper.

3. Teacher Accounts and School Board Responses to Parent Concerns

The article is separated into key sections highlighted below as challenges and innovative approaches and areas of caution and accommodation identified as we transition to postpandemic teaching of mathematics on Google Classroom in Elementary Mathematics classrooms:

(1) Parental Shared Awareness- data regarding the integration of mathematics and technology through the use of Google Classroom in elementary classrooms for students in Grades 5, 6 and 7 and discusses the teacher accounts of experience with parental shared awareness of mathematics teaching and content coverage facilitated through use of Google Classroom for students aged 10-12 years old.

(2) Accountability and Assessment in Collaborative Group Settings.- data regarding the integration of mathematics and technology through the use of Google Classroom in elementary classrooms for students in Grades 5, 6 and 7 and discusses the implications of group collaborative settings, accountability and assessment challenges.

(3) Teacher Perceptions of the Use of Technology in the Elementary Mathematics- data regarding the integration of mathematics and technology through the use of Google Classroom in elementary classrooms for students in Grades 5, 6 and 7 and discusses the implications of teacher competency, collaboration and integration in the development and impediment of mathematics proficiency

(4) Mathematics Identity and Achievement Goals- observations for mathematics engagement, and mathematics identity written journal reflections and goal setting examples from students in Grades 5, 6 and 7

(5) Developing Procedural Fluency Through Video- data regarding the use of uploaded videos to Google Classroom, discusses the advantages through the use of video and the development of procedural fluency for non-subject specialists and students in Grades 5, 6 and 7

(6) Visibility, Sharing and Privacy Protection -data regarding the need for equitable measures that account for vulnerable and marginalized populations and lack of accommodations for students who are sharing contextual, lived experiences of emotions such as mood dysregulation, lower social status, language or cognitive development difficulties, and lack of mathematics/technology support in the home

(7) Institutional Level Policy Formation-data inclusive of rationale and justification of policies at the institutional level, regarding how schools and investigating boards define the security of personal information within a network and the policies and mechanisms of assurance for the protection of staff and student data and the protection of privacy,

(8) Parent Concerns About Surveillance-data inclusive of concerns raised by parents regarding the surveillance and tracking of students and collection of data from the perspectives of the school district and of school district staff that are also parents of students adhering to these policies

3.1 Parental Shared Awareness

Students have a natural urge to share their opinions. Students aged 10-12 years old are seldom given the opportunity to post their voice publicly. Teachers in the study found that, due to the infrequency of students posting, they require teacher monitoring and guidance. Posting work publicly is a powerful tool for increasing engagement for two reasons: the infrequency of the event for students in this age group, and the attention students receive from others online. However data collected from the current study indicates parents may be unwilling to allow their child's name to be identified on Google and ask for a certain level of anonymity to protect their child's participation and input from being tracked.

Although it is possible to use asynchronous communication to develop all mathematical processes, most teachers planned communication opportunities for students. One reason provided was related to a lack of knowledge about how many of his students owned personal technology that could be used to document evidence with pictures. Another reason was the difficulty of using a mouse to draw a shape compared to simply using a pencil and paper.

Teachers provided instructional support through the use of collective brainstorming online with Google spreadsheets, however, he also supplemented these with digital templates so that all students were able to contribute. teachers found the incorporation of technology into his classroom to be easy, however, one teacher found it time consuming and cumbersome, administrative praise and reconginition of the teacher's efforts allowed him to feel his time had been well spent.

Teachers understood that making learning relevant was key to engaging students in mathematics but did not always know how to relate the mathematics curriculum to a real-life experience for students. While teachers valued the collaborative nature of online cooperative learning, students and parent communities did not have the same values. One teacher's approach of guided discovery (Brown and Campione, 1994) and discussion based cooperative tasks were slower paced and raised anxieties in her students and parents when compared to the rapid pace of closed questions the students and parents were used to (Hardman & Abd-Kadir, 2010).

Recent training in mathematics teaching provided multiple tools and a vast background of teaching pedagogy to support a specific style of teaching mathematics that was modeled by learning leaders in the school district. A lack of experience and confidence with teaching mathematics has caused her to rely on mathematics videos to present content to students while providing time to search out answers to questions. For these reasons, the asynchronous nature of Google Classroom accords a time delay for both teachers and students to develop comprehension and review concepts that are not automatic to them yet.

In a representational competency framework, staff and students that lack self-efficacy may still be in the sense-making competency phase. They require time to make connections, and perhaps are also uncomfortable making connections or answering questions during class time, additional time ensures answers to questions are correct. As confidence, experience and content knowledge develops users will develop perceptual fluency and be able to represent and connect mathematical concepts to others in the class at a quicker pace and automatically (Rau et al., 2017).

Google Classroom was used by teachers (Sadownik, 2018) to store shared folders of homework assignments, and to store private folders of student work that were accessible to parents at home. Google Classroom was used to provide links to mathematics videos that students could review outside of her classroom prior to a lesson or after for review with a parent or tutor. Students could also contact teachers privately through Google Classroom if they had a question regarding the math video. One teacher used a homework board located in a shared folder to appease parents who were anxious about the pace of learning in her classroom and to provide additional resources that showed alignment with the topics they were covering in class. Another used podcasts that were stored on Google Classroom for students to review prior to upcoming unit tests. A Google Slide activity was available to parents to view in their child's shared folder and students were free to have public or private folders to share with their classmates.

Teachers in the study (2018) found the availability of online mathematics resources provided parents with a sense of control and autonomy, which lessened the anxiety they expressed to the teacher participants. Each of the teachers in the study had evidence of parental anxiety and interest in mathematics curriculum. For example, parents in one class were anxious about the pace of content coverage and the rigor of the guided discovery approach compared to textbook work. The teacher resolved their anxieties by providing access to resources online from six different textbooks and providing alignment through page references with the guided discovery students had completed in the classroom.

Teachers are able to provid live streaming webinars that demonstrate their teaching methods. Teachers can also provide parents with websites, such as Math Frog and Nelson online that could be used from home to support their child. Varying teachers' approaches to using online asynchronous communication in mathematics allowed parents to work at their own pace with the mathematics curriculum, to assess their child's understanding or develop their own mathematics skills together with their child. Providing access to student work that was stored digitally online in shared folders allowed parents and students to share mathematics learning and engage in discourse.

3.1.8 Providing Access to Online Mathematics Resources

Allowing parents to access math resources from their home was found to increase parent and student engagement in mathematics in some classes. As noted by one teacher, parent engagement may also mean parents feel anxious. Providing shared awareness of curriculum content coverage may also lead parents to ask questions about teaching practices. Shared awareness may also cause parents to engage with the teacher or school in a negative way.

3.1.9 Summary

Key findings related to parental shared awareness in mathematics resulted from the study including Google Classroom were :

(1) Google Classroom may be a powerful tool that increases both parent and student engagement, and increased engagement may lead to heightened anxiety;

(2) Google Classroom was most often used in mathematics by teachers in this study to communicate with parents about content coverage and to communicate mathematics homework and increased communication can be both positive and negative communication or criticism;

(3) Google Classroom may be able to calm parent anxieties about student learning by providing online mathematics resources, however, it may also increase parental anxiety;

(4) Google Classroom is used by teachers to develop mathematical processes online with different frequencies due to their background experience and comfort level, however designing purposeful tasks in an online environment can be time consuming.

3.2 Accountability and Assessment in Collaborative Group Settings

One consideration for teachers who promote cooperative activities is how to assess individual contributions. Coleman (1961) suggests it is challenging to mark individual contributions in group work because of the competitive nature of students and the bank model of deposit and withdrawal. Therefore, one challenge continually presents in cooperative groupings of how to hold students accountable for contributing without evaluating individual contributions.

The NCTM Agenda report (2010) lists assessment as a factor when linking research to practice and considers "What are the characteristics of a comprehensive mathematics assessment system that provides instructional guidance, supports education decision-making, measures continuous growth, and monitors system progress and accountability? (p.) Unpacking this question requires educators to reflect on assessment in 3 ways: purpose of assessment; variety of assessment tools; and transparency.

Challenges for group work accountability and assessment are noted by Gommans et al. (2015) who suggests that despite the potential of collaborative learning, its popularity and simplistic definition, effective collaborative learning is much more challenging to achieve. Effectiveness is measured in terms of 4 distinct areas: 1) Motivation; 2) Quality of interaction ; 3) Structure of the collaborative task; and 4) Similarity and dissimilarity between group members on various individual characteristics (p. 599).

One further consideration for teachers who promote cooperative activities is how to assess individual contributions. Coleman (1961) suggests it is challenging to mark individual contributions in group work because of the competitive nature of students and the bank model of deposit and withdrawal. Therefore, one challenge continually presents in cooperative groupings of how to hold students accountable for contributing without evaluating individual contributions.

Google Classroom allows teachers to monitor and assess student participation as well as shared thinking. Classroom norms that dictate students follow procedures of referencing other's thinking help to develop reasoning and encourage students to share their thought processes, pointing out strengths and potential misconceptions. The additional benefits of viewing thinking in online environments as part of an assessment to guide teaching (VanDerHeyden & Burns, 2005; McNamee & Chen, 2005) and adapt pace (Herppich et. al., 2018 November) are noted in addition to the availability for teachers to track students (ibid).

Evidence collected by Sadownik (2018) demonstrated the benefits of using checklists to help students be accountable for collaborative group work in Google Classroom. Direct teaching is a sharp contrast to beliefs about guided discovery learning (Brown & Campione, 1994) and student discussions about consolidation questions. Evidence collected suggest the incorporation of open-ended questioning strategies and collaborative group work into daily math lesson in addition to inquiry projects can be exciting for students (Sadownik, 2018).

Gommans et al. (2015) note that working together with peers on a task offers many opportunities for students to engage in discourse. Some teachers interviewed in the 2018 study believe that communication is more engaging than textbook work and that students have multiple intelligences. The emphasis on social learning and pupil-pupil dialogue is the main pedagogical implication of Vygotsky's (1978) work and supported by subsequent research (Hardman & Abd-Kadir, 2010). Proponents of Vygotsky's (1978) work therefore require a self-assessment model for group activities may be beneficial for students engaged in collaborative group work that is communication orientated and for teachr assessment. This is aligned with research that suggests the effectiveness of collaboration is increased by offering group rewards and individual accountability (Slavin, 1983); and highlights the importance of both the individual responsibility and communal sharing ideal proposed by Brown and Campione (1994).

The model (Table 1) is used to assess the contribution, cooperation, communication and productivity of the group. The model reveals teaching practice of guided discovery has at least three of the essential characteristics of an ideal community of learners proposed by Brown and Campione (1994): individual responsibility coupled with communal sharing, a community of discourse, and multiple zones of proximal development.

Contribution	Cooperation	Communication	Productivity
Checklist: How are you doing in terms of contribution? Considerations: Contribution doesn't have to be oral contribution Did you help keep group members on task? Evidence: What work you have done quietly on your own? What work can you show to others?	Checklist: How well are you working with the others in your group? Considerations: What do you have to offer to a team? What are the strengths of your team? Evidence: What were the reasons to justify why each member was assigned to do a particular task?	Checklist: Are you participating in group discussions? Considerations: Communication is not always about speaking, it includes listening to others Evidence: Is there a record of ideas? Who is speaking? Who is asking questions? Who is recording the dialogue?	Checklist: How productive have you been? Considerations: Are you contributing useful ideas? How much of your time was focused on the task? Evidence: What is the quality of the completed work?

Table 1-Self-Assessment Model for Group Productivity

3.3 Teacher Perceptions of the Use of Technology in the Elementary Mathematics

Seifert (2016) suggests most teacher education programs are staffed by teachers who were not born into the digital information revolution and suggests the value of mobile technologies has been subsequently overlooked in these situations. Seifert (2016) stresses 21st century learning has emerged with the onslaught of emerging technologies, teaching pedagogy has also transitioned to knowledge building. Seifert (2016) notes, mobile technologies have afforded learners the ability to be independent and autonomous and if teachers are to maintain their role as discovery guides in student-centered instruction, teacher confidence will need to be high.

Non-subject specialists in the areas of mathematics and technology, coupled with a lack of staff collaboration may determine the success of any STEAM project. "Creativity in problem solving is rarely noticed in mathematics learning" (Naja, 2018, p. 1). Ontario Ministry of Education (2020) mathematics curriculum document suggests throughout the course, students actively participate in the learning of mathematics by making connections to their lived experiences and to real-life applications. They continue to develop critical consciousness of how socio-cultural structures within systems impact individual experiences and opportunities, and to shape their identities as mathematics learners. However, A complex range of issues that reflect the needs of mathematics teachers and indicate that these needs are varied in different domains … related to mathematical proficiency (Barham, 2020, p. 3) Sometimes teachers emphasize more to memorize formulas in order to solve problems such as math. Although sometimes this method is considered to be more instantaneous but it actually inhibits the development of students' reasoning and creativity.

Further the Ontario Ministry of Education (2020) notes "Students actively participate in the learning of mathematics by making connections" however, Barham (2020) suggests several teacher competencies may limit students ability to make these connections:

- Some studies have addressed teachers' need to acquire different teaching skills or knowledge that may enhance students' *conceptual understanding*

- There is a need to develop teachers' skills in using mathematical language and symbols, developing spatial visualization, and acquiring knowledge of common core mathematical concepts and ideas that indicate needs related to *conceptual understanding.*
- *T*he most relevant needs were teacher's development of their mathematical knowledge and the acquisition of knowledge that can help them lead their students towards the understanding of mathematical concepts.

3.4 Mathematics Identity and Achievement Goals

Eccles (2009) describes identity in terms of individual perceptions of self. A teacher's and student's perceptions of their ability in mathematics and their perceptions of the value of mathematics both determine their willingness to engage in mathematics. In 2018, there were a number of initiatives to stimulate the investigation of mathematics teaching for students age 10-12 years of age in the province of Ontario, most notably, the Renewed Math Strategy (RMS) and the investment of $60 million in funds to improve mathematics teaching. The Ontario Ministry of Education, through the Ontario Teachers' Federation (OTF), provided a subsidy to teachers that completed additional qualification courses in Mathematics or Technology. The influx of teachers who were engaged in mathematics training provided an ideal setting to investigate teaching practices that highlighted mathematics reforms and provided insight into challenges faced by teachers through their lived experiences in the classroom teaching math.

This section presents findings about one teacher's use of video in a Grade 5 class, reflections about feelings of anxiety towards teaching mathematics and decisions to offer a flipped classroom approach to teaching where the students view videos of course content available through the available Google Classroom. The teacher then sits with students who are feeling frustrated with questions. It is very important to for teachers to build relationships with students. Building relationships with students allows them to feel comfortable engaging in open dialogue about what they are learning and facilitates conversations about what students are struggling to learn. Strong relationships with students also helps educators to work with students to set goals for their learning.

Teachers may find it helpful to let students watch a mathematics video before starting the lesson to front load material and appease anxiety. Videos can be uploaded to Google Classroom and may enable some students to begin working on a task directly after the video ends. This approach reinforces beliefs that students should advocate for themselves and is used to empower students and their parents by offering the material to view at their leisure. In this way Google Classroom facilitates opportunities for her students to work independently and regulate their time (Zimmerman & Kitsantas, 2005). Students are also able to watch the video multiple times and to ask questions related to the content.

Connecting mathematics learning and teaching with media and humour may increase student engagement and motivation during math lessons. Sadownik (2018) found evidence that students were more engaged when viewing the videos provided of math content than when engaged in direct teaching in person. Researchers have discussed the benefits of video in teaching and learning (Hyde, 2007; Schoenfeld, 2016). While Hyde (2007) notes viewing material multiple times increases retention. Schoenfeld (2016) highlights the uses of video in understanding and improving mathematical thinking and teaching, both in his research and in his teaching practice and suggests he has collected evidence as to the powerful "impact" of using video (p. 7). An educator's lack of self-efficacy may be appeased through the use of Google Classroom and the connections students make between the video and math in the classroom may increase their engagement with learning mathematics (Sadownik, 2018).

3.6 Visibility, Sharing and Privacy Protection

The use of privacy impact assessments (PIA) were identified by IT staff in case study two "we have over 200 different apps that are used by teachers in the district, we did inventory, so for a lot of them we do have privacy impact assessments in place, but for a lot, teachers may just choose an app because they saw it somewhere and they liked it, or they came across it from another teacher. That is an area we struggle with, is how do we manage, how do we ensure that we have the right privacy controls in place."(CS2-1a).

The concern for school districts, and in particular IT staff is what data is being uploaded, "If a service wants to get a list of all of the students and their names and their email addresses and things then we do have to do a privacy assessment. So when we are uploading data we definitely do it." (CS2-1b). Over the past five years in the province of British Columbia, IT staff have been implementing provincial policies related to data storage and retention, "It is a provincial, it has only been in the past 3 or 4 years, that it has really been an issue as cloud computing became more prevalent. It kind of started with Google Apps for Education and went on from there, office 365" (CS2-1b). The lack of control has caused some IT staff to feel uneasy, "a few years ago organizations including school districts were in control, well had a lot more control over where their data was located because it is actually located physically within their own data centre" (CS2).

When IT staff are asked about the role they play in surveillance, one school district attributed a portion of their work to reviewing apps that teachers and students could use "trying to find that fine line between where the tool is actually useful and it is contributing to the learning versus situations where it is inappropriate or distracting from the learning process" (CS2-1a).

Personal devices brought to the school and connected to the school wireless fidelity (wifi) are subject to monitoring of those devices…" (CS2-1b). From a security perspective, personal devices are also kept apart from district owned devices through the use of separate networks for accessing the internet. "Yes, it is for security, because we don't trust those devices, we don't control them, we don't trust them." (CS2-1b). The concern for this school being the potential for malware or malicious files downloading or uploading to district resources through the internet connection (CS2-1b). IT staff have in both case studies "isolated to a separate network from the main devices" (CS2-1a); and "no intent on giving them access to files on district, or district files rather, just letting their device connect to the

World Wide Web" (CS4). Regardless of which network, "We do have, I will say filters, on our staff or on our BYOD and those are, there are just certain websites that are blocked right. and you can't access them right and that is for everyone, the students and the staff right, we don't want them accessing certain sites right?" (CS4).

3.7 Institutional Level Policy Formation

The use of Google and Google Apps for education by many school districts has also lead to changes in policy, "Google has a policy on how they treat student data many of these software companies have those kind of policies so I have kind of put together a list of all of those that we will send a parent if they ask, say they want to find out more about how their child's privacy is protected, that type of stuff." (CS2-1a). Plans to include policy statements related to privacy were discussed with IT staff in case study four, "We do reference FOIPPA when it comes to that and sharing that information online is not encouraged, for sure. So that could be addressed in BYOD procedure as well" (CS4).

Depending on the school district, a policy that regulates the type of devices a student is allowed to bring in may exist, and an acceptable use policy for computer devices may exist, but an acceptable use policy for student personal devices may not, "So, I will say it isn't well defined right now and we actually are working on an administrative procedure on BYOD so what we do have right now is one procedure that has to do with the use of technology in the district, right" (CS4).

Both case studies with IT staff participants echoed the same response, "What we have is for the use of all communication devices, we essentially have a procedure that we put in place, that let's them know that anything and everything on their computer can and will be monitored if required. It is not specific to BYOD but it is just general use of all computing devices" (CS2). Having a district wide acceptable use policy is strategic for IT staff "Especially from a FOIPPA compliance perspective, including their personal devices, if they use their personal devices in the classroom" (CS2). However, there exists some contextual considerations for access to websites

The administrator/parent in case study three collaborated with her staff and felt strongly connected to the policy at her school, "five years ago, we had an incident with what we as a staff deemed to be inappropriate use of cell phones and social media in schools and we developed a policy" (CS3) "every single staff member and myself it was a completely collaborative effort that lead us to the policy that we have"(CS3)

For case study four participants there is only one procedure for the use of technology and it is district wide, not BYOD or site specific. (CS4). IT staff in case study two worked with their union on a general consent document for the use of "all computing devices" (CS21b) and even for both IT staff participants in case study two and four, some policies are not in their control either "We do reference FOIPPA when it comes to that and sharing that information online" (CS4) and "a FOIPPA compliance perspective, including their personal devices, if they use their personal devices in the classroom" (CS21b). While it might be

assumed that it is true in all school districts, participants in case study two acknowledged policies had been approved by the board around the use of information (CS2-1). A quick scan of their policy documents by participants in case study two noted their school district policy does not identify the possibility of accommodations for marginalized or vulnerable populations. “I don’t think there are any accommodations for marginalized or vulnerable. I don’t think there is anything that we do related to that, I don’t know if there is anything the schools do that are related to that”
(CS21b).

3.8 Parent Concerns About Surveillance

Since the shift in control some school districts are struggling with their application of privacy matters, “That is an area we struggle with, is how do we manage, how do we ensure that we have the right privacy controls in place” (CS2). Everything now is on the cloud, right.” (CS2). Parents have requested greater privacy controls in some cases, “we have a parent that will not give us consent to allow their child to be on GAFE using their regular name. They want to use a randomized name like island life or something like that which encloses its own sort of issues like how do the teacher or students know who that student is” (CS2). Both school districts rely on FOIPPA for guidance in privacy matters and sharing information (CS2; CS4).

Different perspectives were observed during the study in relation to the surveillance or collection of data at school. In case study two, IT staff reflected on a challenging situation with a parents refusal to give consent for their child’s name to be used on Google Apps for Education (GAFE) and they expressed confusion on how a teacher could assess a child in this manner effectively, “they want to use a randomized name” (CS2-1a).

Safety is a key reason for students to have cell phones as a device at school, “many of our students using their phones, or computers log on to their school wifi through their student accounts” (CS3). Policies for student cell phones also exist and rely on the parent to to sign the electronic device agreement for their child. This approach is mirrored by the IT staff in case study two, “we ask parents to give us consent for their child to access any internet-based resources” (CS2-1b). It also mirrored the approach by IT staff in case study four “appropriate use consent form we send home at the beginning of every school year” (CS4).

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