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Teachers' perceptions of using technology to teach mathematics during COVID-19 remote learning

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Teachers' Perceptions of Using Technology to Teach Mathematics During COVID-19 Remote Learning

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Abstract

There are concerns that current remote learning efforts in response to COVID-19 may not be measuring up to the quality of classroom-based instruction. This study investigated two high school teachers' perceptions of the issues surrounding teaching mathematics remotely and factors that contributed to their use of technology while teaching online. The results show that both teachers found teaching mathematics online more difficult compared to classroom-based instruction. The main concerns expressed by these teachers focused on challenges related to receiving feedback from students and limited student interaction. This made it difficult to assess students' understanding during lessons. They also expressed concerns about the difficulty of implementing aspects of a task-based curriculum that relies heavily on classroom discourse and interaction; and the challenge of finding quality and usable resources for remote instruction. This study also identified several factors that influenced teachers' use of technology during COVID-19 remote learning. Implications for teacher professional development, online instruction, and policy are discussed.

Keywords: COVID-19 pandemic, remote learning, technology, perception, MVP curriculum, classroom-based instruction.

Percepciones de los Maestros sobre el Uso de la Tecnología para Enseñar Matemáticas Durante el Aprendizaje Remoto de COVID-19

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Resumen

En este estudio investigamos las percepciones de dos profesores de secundaria sobre los problemas relacionados con la enseñanza remota de matemáticas y los factores que contribuyeron a su uso de la tecnología mientras enseñaban en línea. Los resultados muestran que a ambos profesores les resultó más difícil enseñar matemáticas online en comparación con la enseñanza presencial. Las principales preocupaciones expresadas por estos docentes se centraron en la dificultad para recibir retroalimentación de los estudiantes y la interacción limitada de los estudiantes. También expresaron su preocupación por la dificultad de implementar aspectos de un plan de estudios basado en tareas basadas en gran medida en el discurso y la interacción en el aula; y el desafío de encontrar recursos utilizables y de calidad para la instrucción online. Este estudio también identificó varios factores que influyeron en el uso de la tecnología por parte de los maestros durante el aprendizaje remoto de COVID-19. Se discuten las implicaciones para el desarrollo profesional docente, la instrucción en línea y la política.

Palabras clave: COVID-19 pandemic, remote learning, technology, perception, MVP curriculum, classroom-based instruction.

In the wake of the COVID-19 pandemic and the need for social distancing, education stakeholders around the world have been forced to explore different options for remote learning such as use of online platforms (e.g. Zoom, Google classroom. etc.), educational television broadcasts, websites, and so on, as schools were partially or completely shut down. Some of these alternative means of instruction delivery that schools around the world are employed are well documented in OECD's 2020 report titled "A framework to guide an education response to the COVID-19 Pandemic of 2020". While there is no arguing the fact that remote learning is the way to go in times like this, there are fears that current efforts to keep learning going may not be measuring up to the quality of classroom-based instruction (Dorn et al., 2020). Teachers were forced to teach remotely even though many of them did not feel prepared to do so (Newton, 2020). The abrupt transition to remote learning due to COVID-19 has also reinforced extant discussions around equity, access, curriculum, assessment, teacher preparation, and pedagogy, especially in the context of remote learning.

The literature is replete with studies of teachers' use of technology in mathematics classrooms (Cuban et al., 2001; Bauer & Kenton, 2005; Goos & Bennison, 2008; Afshari, Bakar, Luan, Samah, & Fooi, 2009); however, there is a paucity of studies that investigate remote instruction during pandemics and they hardly focus on mathematics (Almanthari et al., 2020). This study focuses on the experiences of two high school mathematics teachers from two different schools and counties in North Carolina who had to teach mathematics remotely for the first time due to the COVID-19 pandemic. The study addressed the following research questions:

- What are perceived issues surrounding teaching mathematics with technology remotely during the COVID-19 pandemic?
- What factors influenced teachers' use of technology for mathematics instruction during the COVID-19 pandemic?

Literature Review and Framework

The present study is based on McCulloch et al.'s (2018) framework for guiding technology integration decisions in the mathematics classroom. We

also draw from learning environment research which describes the learning environment, whether face to face or online, as having three primary components: social, psychological and pedagogical components (Fraser, 1998; Huang, 2012; Fraser, 2012; Tootonchi, 2014).

Based on a study of the factors that influenced 21 secondary mathematics teachers' integration of technology in mathematics lessons, McCulloch et al. (2018) proposed a framework to describe teachers' decisions about integrating technology while attending to student learning, access, and compatibility which might be otherwise neglected. Even though the context of McCulloch et al.'s (2018) study is the use of technology in an in-person setting, their conceptual framework is relevant for discussing factors that influence teachers' use of technology in a remote setting.

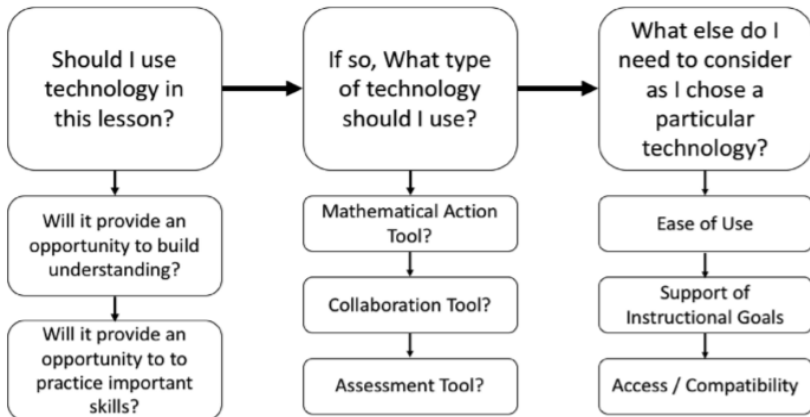


Figure 1. Framework to guide technology integration decision (McCulloch et al., 2018)¹

This study focused mostly on the pedagogical component of the learning environment during COVID-19 remote learning as it described teachers' practices and decisions around technology use. Bernard et al. (2004) noted that the pedagogical component of teaching plays a more significant role in students' learning compared to the medium of learning or classroom format (e.g. face-to-face, blended, online). Whether one considers a face-to-face setting or an online setting, the learning environment (comprising the social, psychological, and pedagogical components) is important, it can determine

both the level of student satisfaction as well as the quality of the learning experience (Schulz & Barvi, 1986; Lorenzo, 2007).

Although there is significant research that has focused on online learning, very few studies have looked at online learning in the context of the COVID-19 pandemic (Kaden, 2020; Sangster et al., 2020; Reich et al., 2020). This study contributes to filling that gap.

Methods

Participants

The two participants included in this study, Bob and Anna (pseudonyms), are both high school mathematics teachers recruited through an alumni email list of 50 participants who had completed the TMT (Teaching mathematics with technology) MOOC in Spring of 2019. The first participant, Bob, has 14 years teaching experience while Anna has 20 years. Bob and Anna come from schools located in a suburban and urban community respectively. However, their students come from mixed backgrounds.

Data Collection

Semi-structured 30-minute interviews were conducted remotely to collect data using the video conferencing software, zoom, and also recorded. The Interview protocol was designed based on issues related to use of technology during face-to-face and online instruction, especially in the context of the Covid-19 pandemic, as identified from the Literature. Some of these issues include access, equity, preparation, social distancing, tech support, grading, etc. (McCulloch et al., 2018). Teacher participants also shared instructional resources such as handouts, activities, and links to websites which they used during face-to-face and remote instruction with the researchers. In the long run, this study is part of the build up towards answering the question: how much of teachers' use of technology during face-to-face instruction (post-pandemic) is influenced by their experience of teaching remotely during the Covid-19 pandemic?

Data Analysis

A codebook was developed based on transcripts of interviews automatically generated from zoom using theory and data driven approaches as described in DeCuir-Gunby et al. (2011). Both authors discussed and agreed on code labels and their definitions. Data was coded separately by both authors and later compared; the inter-rater reliability was 96%, indicating a high degree of agreement between both authors. Preliminary results are presented in the next section under two of the five main themes developed from coding the data.

Preliminary Findings

This section discusses findings from our analysis as they relate to participants' perception of issues surrounding teaching mathematics with technology remotely during the COVID-19 pandemic and factors that contributed to their use of technology.

Perceived Issues Surrounding Teaching with Technology

Findings related to teachers' perception of issues surrounding teaching with technology are discussed under pedagogy, scheduling, family obligation, student feedback and interaction, assessment, quality and usability of resources, support for transition, Teacher collaboration as follows:

Pedagogy

Both teacher participants felt it was more difficult teaching online or implementing the curriculum online compared to doing so in a face- to-face setting. The result was that these teachers had to let go of certain tasks/content, and sometimes teach specific concepts or units without going in depth. Bob noted that he had to focus on the basics:

I mean, it's just harder (referring to online instruction)... And so I tried to kind of minimize things, like if we were doing graphs of sine and cosine, I didn't give them anything where the x-axis was like a weird stuff where they were going to have trouble with fractions. I was just trying to make them understand the basic things so that they have at least a little foundation going forward.

Anna also mentioned how she had to adjust tasks while implementing the mathematics vision project (MVP) curriculum to make them amenable to online instruction:

So, I worked on reducing the noise of the tasks [extra information included in word problems] because I wanted the feedback to be really specific to the kids' answers...

Support for transition

Teacher participants indicated that they received support in form of emails with links to resources, PLC meetings where issues relevant to the transition were discussed, and live or recorded professional development sessions, as part of preparation for transitioning to online instruction. While Anna felt teachers in her school received meaningful support in their preparation to switch to online instruction, Bob didn't think the support he received was very helpful.

Quality and usability of resources

Another issue that came up as participants answered questions about their experience teaching online relates to the kinds of resources they accessed. Bob expressed frustration over the quality of resources available for online instruction and teaching in general and how one must do everything himself or depend on others. The following excerpt captures his submission:

... there are no real good resources designed for us anymore... So it's like doing everything with your hands, it's awful. Like I would not want to start teaching right now...not necessarily because of the pandemic, everything is just... your resources are other people or you're making everything yourself. And I feel like even as good as the counties have tried to give people resources, there's nothing good out there.

Anna also mentioned that the designers of the MVP curriculum have already created some resources to help teachers implement the curriculum online but are limited because there are few hands working with them:

They've already built (referring to MVP resources for remote learning), but it's desmos. They're building a lot of teacher activities for desmos. They're too small, they don't have enough people working with them. So, they're trying to crowdsource that work on

their little Facebook group and trying to get teachers to submit stuff from that.

Scheduling

Both teacher participants noted that class schedules during the pandemic generally changed and became more flexible to better cater to students.

Family obligation

Both teacher participants expressed concerns about how family responsibilities that students became engaged in as a result of the pandemic (e.g., babysitting younger siblings) made it difficult for them to attend synchronous sessions.

Assessment

Bob noted that testing during the pandemic was not helpful. He described how he went about testing his students during the pandemic and noted that there is no way to secure testing during online instruction. Thus, Bob expressed concern about the issue of academic integrity:

If kids are going to be honest and do their work, I feel like something like that is a helpful way for them to show their mastery of a topic. I mean testing in an environment like this, I don’t think is very helpful. And so, I think just giving students a way to demonstrate their mastery is kind of what you need to shoot for in this situation, instead of can you perform this math problem under pressure.

Student Feedback and interaction

Both teacher participants reported that student interaction was difficult to maintain online, and this affected feedback. They noted that challenges around interaction affected the quality of feedback they got from students during remote learning. Bob expressed frustration over poor feedback from students during remote instruction as follows:

I felt like it was limiting (referring to remote instruction) because in a classroom setting, you get that constant feedback like I ask a

question and people are silent. I'm like, I don't know what's going on. So, we got to go back and figure this out. Online, It's just you, you're kind of throwing everything out there and hoping it sticks, but you don't know.

Anna also expressed concern about how poor feedback and interaction made it difficult to implement the task-based MVP curriculum which depends heavily on classroom discourse and interaction online:

We do use math tasks; we have a curriculum that we use. It's the mathematics vision project. And so, it's task based which means it tries to follow the effective teaching practices from NCTM which has been difficult to think about how you do that online because it depends a lot on classroom discourse and interaction with the students. So that's been on my mind pretty heavily.

Teacher collaboration

Teacher participants noted that there was more collaboration among teachers during the pandemic. Teachers collaborated in planning lessons and making instructional videos.

Factors that Contributed to Teachers' Use of Technology During Online Learning

This section discusses different factors that influenced or contributed to teachers' use of technology during COVID-19 remote learning:

Equity and Access

Both teacher participants took issues of access and equity into consideration in decisions about technology integration and online instruction in general. Bob noted that he taught students who do not have scientific calculators how to use Desmos online to compute permutations and combinations. Bob also made a room for alternative submission options for students who may not be able to easily submit their assignments through Canvas due to internet access problems:

And so, for assignments, I still kind of used the handouts that I was giving kids, just send it to them that way. I figured if they didn't have

access to the internet at home, they could go somewhere and download it and then do it on a piece of paper and send me a picture.

On her part, Anna discouraged the use of Khan academy videos, arguing that they are not suitable for EL and EC students because the language is strictly academic from the beginning and there is an assumption of prior knowledge.

a lot of my teachers wanted to use Khan Academy videos because they were already made. And I did not want that to happen, because I don't feel like those are accessible for EL and EC.

Anna also noted that every student in her school was given a laptop device, and where students didn't have internet access, provision was made for hotspots or Wi-Fi.

Prior Experience Teaching with Technology/ Ease of Using or Learning to Use New Technology

Teacher participants' prior experiences teaching with technology and the ease of using technology (or learning to use new technology) also influenced what technologies they used during COVID-19 remote learning. Bob noted that he stuck to Google classroom at the beginning of online learning even though it was not as organized as he wanted. Anna noted that she was not familiar with statistics tools online and no one knows how to use them among her teachers and that it was difficult to introduce new tools for collaboration to students in an online setting.

Privacy

Another factor that influenced technology use was concerns about privacy. Anna noted that parents in her district objected to the recording of synchronous sessions with students:

...the biggest thing on my mind is that our lawyers for our district will not allow us to record synchronous sessions with students.

Time

Both teacher participants agreed that time was a major factor that influenced the extent to which they incorporated technology during remote instruction.

School influence or directives about technology use

School influence or directives related to technology use also contributed to the kinds of technologies teacher participants used. Bob mentioned that his school told teachers to use either Canvas or Google classroom. Anna also noted that her district switched from using Google classroom to Canvas because they believed it was more helpful for *parent partnership*. The school also wanted to maintain the same type of course navigation for students for all classes. Previously, there was no uniformity in the kinds of technology teachers used.

Discussion

While online learning has become a lifeline for ensuring that students continue to learn during the COVID-19 pandemic, the abrupt transition to remote learning due to COVID-19 has reinforced extant discussions around equity, access, curriculum, assessment, teacher preparation, pedagogy, and so on. The teacher participants in this study both perceived online teaching as more difficult compared to classroom-based teaching. This finding corroborates Marshall et al.'s (2020) who reported that Teachers found all aspects of teaching more challenging during COVID-19 remote instruction. For these teachers, the switch to online instruction was abrupt. As such, their conclusion is not unconnected with their level of preparation. Crompton et al. (2020) noted that there is a lack of teacher preparation for online teaching in planned situations, and that the lack of teacher preparation is further exacerbated during emergencies due to several other challenges. In the case of the teachers we interviewed, some of these are connected to issues related to pedagogy, quality and usability of resources, scheduling, assessment, students' family obligation, student feedback and interaction.

Although findings from some studies (Bernard et al., 2004; Means et al., 2009) have shown that the learning format (face-to-face or online learning) does not make much of a difference in students' learning, the results of this study show that the pandemic may have impacted teaching negatively. For example, both teacher participants reported adjusting or sometimes simplifying the tasks they gave their students just to keep learning alive. In fact, Bob noted that he focused on basics just to ensure that students have "a

little foundation going forward”. This focus on basics seemed to have also reflected in the way Bob used technology in his classroom, judging from a comparison of the lessons and tasks before and during the COVID-19 pandemic which he shared with the researchers. Ana also noted that she adjusted tasks to keep things simple.

Both teachers pointed out the issue of poor student feedback and interaction as challenges that came with COVID-19 remote learning. These are perhaps the biggest challenges that Ana experienced considering that online learning made it difficult to implement aspects of the task-based MVP curriculum which depends heavily on classroom discourse and interaction. Anna’s experience raises issues about curriculum design and online instruction. In the same vein, both teachers’ comments about the quality and usability of available resources (mostly designed for traditional settings) for online instruction also raises concerns about the extent to which many of the resources available to teachers are suitable for online instruction.

While some issues related to COVID-19 remote learning clearly affected learning negatively, the fact that the pandemic brought about greater teacher collaboration, made scheduling more flexible, and possibly gave students greater control of their time (students didn’t have to attend synchronous class sessions every time) are some positive aspects of the COVID-19 remote learning. Some of the issues surrounding teaching remotely as described in this study have been identified in a similar study by Almanthari et al. (2020) who described the challenges secondary school mathematics teachers faced implementing online instruction during the COVID-19 pandemic in terms of four barriers: teacher, school, curriculum and student level barriers.

This study also identified several factors that influenced teachers’ use of technology during the pandemic: equity, access, knowledge of technological tools, privacy, time, prior experience teaching with technology, ease of using technology, and parent partnership. These factors played a role in what technologies were used and sometimes why they were used. There are different studies that have described factors that influence teachers’ integration of technology in their classrooms (Ertmer, 2005; Karagiorgi & Charalambous, 2006; Tatar, 2013). However, a focus on factors that influence teachers’ use of technology during the COVID-19 remote learning is probably new; this is especially so considering the fact that the pandemic is unprecedented. One of the main contributions of this study is that it identified

additional factors (e.g., equity, access, parent partnership, school policy, and time) that guide or influence teachers' decisions about technology integration in the classroom besides those described by McCulloch et al. (2018). As such, it is useful for expanding McCulloch et al.'s (2018) framework.

Conclusion and Implications for Policy and Practice

There is no doubt that the impact of the COVID-19 pandemic on education will stay with us for a long time. While the massive shift to remote instruction has helped to keep learning alive, it is important for both policymakers and other education stakeholders to think of ways to ensure that teachers are maximizing the provisions of the online learning environment so that the quality of online instruction during the pandemic, at minimum measures up to that of classroom-based instruction. As earlier noted, there are studies that suggest that the learning format (whether face-to-face or online) does not make much of a difference in student learning. Hence, there is a need to give attention to pertinent issues that impact remote learning, especially in the light of the findings from this study. One step in that direction is to pay close attention to the different issues surrounding COVID-19 remote learning, this should include teachers' pedagogical practices and decisions around use of technology. There is a need for professional development that trains teachers on principles of effective online instruction and use of technology in online settings; such training should pay attention to both the social, psychological, and pedagogical components of the online learning environment. Additionally, there is also a need for more educational resources, for example, branded textbooks and other curriculum materials that are suitable for online mathematics instruction.

The abrupt transition to online instruction has raised several issues around equity and access. As such, there is a need for new policies that will mitigate challenges that students from low socioeconomic backgrounds and those with special learning needs are likely to encounter while learning remotely. There is also a need for schools to better prepare for emergency situations that may occur in the future by putting incorporating some of the lessons learnt during the COVID-19 remote learning into school policy and practices post-pandemic. Some of these borders on teacher collaboration, scheduling, student, and teacher agency. For example, Crompton et al. (2020) suggest that

future school calendars should have days set aside as digital learning days. Without doubt, the COVID-19 crisis is forcing us to think about the future of education; there is a need to strengthen public education and give attention to public school financing as part of preparation to enter that future. Finally, while the results of this study are important; there is a need to interpret the findings about online learning carefully considering calls by some researchers to differentiate between emergency remote teaching due to a crisis situation like the COVID-19 pandemic and regular online learning that happens in “normal times” (Hodges et al., 2020).

Footnotes

¹ From “Factors that influence secondary mathematics teachers' integration of technology in mathematics lessons,” by McCulloch et al., 2018, *Computers & Education*, 123, p.38. Copyright by Elsevier B.V. <https://doi.org/10.1016/j.compedu.2018.04.008>

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