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MATHEMATICS TEACHERS' ONLINE TEACHING EXPERIENCE IN TIMES OF SCHOOL CLOSURES: THE CASE OF MALAYSIA

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ABSTRACT

Purpose – Given that students were out of school in response to the COVID-19 pandemic public health measures, traditional teaching practices have been forced to switch to online mediated learning environments. This study represents the first research effort to capture the experience of Malaysian mathematics teachers about their teaching during the pandemic. This includes investigating digital education tools mathematics teachers used, issues they encountered, and the knowledge and skills they need to improve during the enforced online teaching situation.

Methodology – This study employed a survey design and qualitative data were collected using an online questionnaire. A total of 202 primary and secondary mathematics teachers from Malaysia participated in the study. The data were analysed through thematic analysis and descriptive statistics.

Findings – First, it was found that the mathematics teachers employed a variety of digital education tools during the pandemic and the most commonly used tool was WhatsApp. Second, the top two issues faced by the teacher respondents were due to internet problems and students' engagement during the online learning. A particular striking finding revealed that three-fifths of the teacher respondents who were concerned about the issue of students' engagement were secondary mathematics teachers. Third, findings of the study further clarified that most of the teacher respondents wanted to improve their technological skills.

Significance – This study supports mathematics teachers in making informed decisions about their teaching during school closures. The findings of this study also serve to alert the education sector about the issues related to the implementation of online education in times of the pandemic. In general, this study necessitates in developing preparedness for future pandemics.

Keywords: COVID-19 pandemic, digital education tools, mathematics pedagogical technology knowledge, online teaching experience.

INTRODUCTION

The COVID-19 pandemic has impacted education worldwide. As of mid-April 2020, 1.5 billion students from over 195 countries were out of school in response to the pandemic public health measures (UNESCO, 2020). Teachers and students were forced to engage in teaching and learning from home, enforcing technology usage as the best approach to sustain education during this pandemic. This resulted in a rapid digitalisation of teaching and transforming traditional classrooms into online classrooms (Daumiller et al., 2021; Kim, 2020). The sudden shift leveraged the implementation of digital education tools to ensure the continuation of schooling.

In some countries, teaching in times of the pandemic depends mainly on video conferencing platforms. This online mode of delivery has been considered as the most sensible way to sustain learning during school closures. For example, teachers in Sweden used mostly Google Classroom and Google Meet (Bergdahl & Nouri, 2020). Mathematics teachers in the Netherlands, Germany, and Flanders, on the other hand, employed primarily Microsoft Teams or Zoom (Drijvers et al., 2020). Although the study of Drijvers et al. (2020) provided substantial information on distance mathematics teaching during COVID-19 lockdown, there appears to be a lack an examination on what difficulties mathematics teachers encountered in teaching practices during the pandemic. In other countries, such as Indonesia, video conferencing teaching platforms are not the first choice for education continuation. This is evidenced in the study of Irfan et al. (2020) in which lecturer participants depended mainly on the university-based website to deliver online learning as compared to video conferencing, such as Zoom and Skype.

In Malaysia, it was indeed a critical and unprecedented experience for both teachers and students due to the lack of experience on a full mode of online education. To support teachers in online teaching implementation, the Malaysian Ministry of Education recommended various online learning platforms, such as Google Classroom, Microsoft Teams, EduwebTV/CikgooTube, Edpuzzle, Quizizz, and Kahoot (MOE, 2020). Using Google Trends, Izhar et al. (2021) searched the trend of using Google Classroom among 52 regions worldwide and found that Malaysia was the top in using Google Classroom between mid-March 2020 and early May 2020.

Problems related to teaching mathematics online arose despite the introduction of different teaching platforms to support remote education. The study performed by Mailizar et al. (2020), for example, postulated that mathematics teachers in Indonesian schools encountered difficulties in explaining mathematical concepts visually, with graphics, or in symbolic terms when using online teaching tools. As emphasised in their study, mathematics teachers faced a great difficulty in using e-learning as a teaching tool when they examined 159 Indonesian secondary school mathematics teachers' views about the barriers related to the implementation of e-learning during the pandemic. Although Mailizar et al. (2020) provided evidence on the difficulties experienced by mathematics teachers in coping with

teaching through electronic platforms, the study lacked insights about the extent to which mathematics teachers from different education levels other than secondary education conduct virtual teaching as an alternative to traditional classroom teaching.

Shifting from face-to-face interactions to online mediated learning environments led to a range of issues that have inflicted a high stress level among teachers (Bhat et al., 2020; Wang et al., 2020). It intensified teachers' workloads during the pandemic (Allen et al., 2020) and they were required to work extra hours to develop electronic content and set up online platforms. Some teachers were also compelled to make decisions on how to teach virtually due to little experience in preparing electronic materials and navigating online platforms.

Apparently, students appear to lack technological skills in operating online learning tools and some even experience devices shortages, such as computers, laptops, and smartphones to access online classrooms and learning materials (Daniel, 2020; Mailizar et al., 2020). Moreover, a limited or uneven coverage of the internet may restrict the access of video streaming and class teleconferencing. To start an online classroom, the study of Rahman et al. (2021) highlighted the necessity of good internet connection. They also claimed that connectivity is a core requirement to sustain students' participation towards effective collaborative activities. From another vantage point, the challenges for students who have stable internet connection are twofold. First, they have to actively engage with digital resources (Hartnett, 2016) and, second, they have to make informed decisions to meet the learning goals at their own pace (Lin & Hsieh, 2001).

Accessibility and availability of learning resources have emerged as another significant concern of virtual education. When studying from home, students' learning materials are limited to textbooks, workbooks, and some reference books. This is supported by Selvanathan et al. (2020) in which they indicated that students were unable to download resources due to limited e-library services. Moreover, the problem of internet access has further restricted students from gaining these materials. All these issues are worth the attention to endeavour for a better support for teaching in times of a pandemic.

An analysis of the literature revealed that recent research that were conducted in Malaysia focused on examining the general education continuation during the pandemic but with the exception of school mathematics teaching. Most of the studies examined online learning of university students (Nassr et al., 2020; Rahman et al., 2021; Selvanathan et al., 2020) and some discussed online teaching from the perspectives of university academics (Bahar et al., 2020; Juhary, 2020; Ramayah & Kumar, 2020). The literature is lacking an investigation on primary and secondary school mathematics teachers' perspectives about the enforced online teaching mathematics in a local context.

Taken together, this study aims to capture mathematics teachers' experience of virtual teaching during school closures. This includes the investigation of digital education tools usage, issues encountered, and the knowledge and skills required for improvement during the enforcement of online teaching. Findings of this study may support mathematics teachers in making informed decisions for online teaching and to alert the education sector about the issues related to the implementation of online education in times of school closures. This study could also help in developing better preparations for future pandemics. This study, therefore, aspires to answer three research questions: (1) What are the digital education tools used by mathematics teachers to teach during school closures?; (2) What are the issues encountered by mathematics teachers in their teaching during school closures?; and (3) What are the knowledge or skills mathematics teachers need to improve during school closures?

Mathematics Teachers' Knowledge and Skills

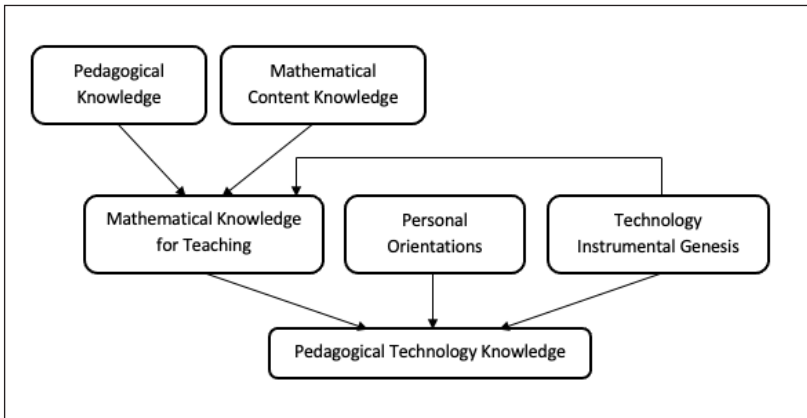
Prior to this pandemic, teachers have been expected to implement technology in their teaching because it may enhance students' learning (Loong, 2014). In Malaysia, for example, technology is integrated into teaching to promote creativity, thinking skills, reasoning ability, and innovation (Sailin & Mahmor, 2018). This is particularly true for the learning of mathematics because the use of technology triggers a mathematical justification, provides a visual environment for three-dimensional (3D) concepts, and enables accurate drawing of geometry objects (Nisiyatussani et al., 2018; Saadati et al., 2014). In a broader sense, technology is used as a supplementary teaching tool in primary and secondary classrooms (Hayes, 2007); however, with the shift to

online education due to the pandemic, the pedagogy of technology usage has received great attention and has become the best way to sustain the teaching and learning processes.

Mathematics Pedagogical Technology Knowledge (MPTK) is orientated to understanding teachers' use of technology in teaching mathematics (Ratnayake et al., 2020). This framework is appropriate for the context of the present study because this study investigates mathematics teachers' teaching in times of school closures in which technology is the fundamental tool to continue the process of teaching and learning. As illustrated in Figure 1, MPTK comprises mathematical knowledge of teaching, technology instrumental genesis, and personal orientations (Thomas & Palmer, 2014).

Figure 1

Mathematics Pedagogical Technology Knowledge (Adapted from Thomas & Palmer, 2014).



Mathematical knowledge for teaching refers to “mathematical knowledge needed to perform the recurrent tasks of teaching mathematics to students” (Ball et al., 2008, p. 399), and its root frames two major components, which are subject matter knowledge and pedagogical content knowledge. Subject matter knowledge is vital to teachers because an understanding of content is a core requirement for the purpose of teaching. Another knowledge unique to teaching is pedagogical content knowledge. It bridges subject matter knowledge

and the practice of teaching so that the content is comprehensible to students (Shulman, 1986). Pedagogical content knowledge builds on subject matter knowledge; however, it is different from subject matter knowledge. It involves the use of powerful analogies, illustrations, representations and so on, but not limited only to the deep understanding of the domain itself. The highlight of the MPTK framework is the integration of the component technology instrumental genesis. In the case of online teaching mathematics, technology serves as a tool to promote understanding in a mathematics classroom (Ratnayake et al., 2020). Mathematics teachers have to convert different technologies into pedagogical instruments, and this is of particular importance especially during this time of the pandemic. The MPTK framework also considers teachers' personal orientations that is "beliefs, motivations, and attitudes relating to the technology use in mathematics education" (Clark-Wilson et al., 2020). Nevertheless, the present study is not designed to capture teachers' teaching orientations, their beliefs, or attitudes towards the technology used. Instead, the focal point of this study emphasises how mathematics teachers approach their teaching and what are the knowledge and skills they need to enhance during school closures.

To effectively teach in online settings, mathematics teachers are expected to apply their mathematics pedagogical technology knowledge in the teaching and demonstrate the knowledge into different online teaching skills. Albrahim (2020) classified online teaching skills into six different categories. In this case, skills may be regarded as the ability to apply knowledge to specific situations. In this study, the MTPK framework is combined with Albrahim's online teaching skills (see Table 1) to fully understand the areas that require further improvement in relation to mathematics teachers' knowledge and skills when teaching virtually.

Table 1

Mathematics Pedagogical Technology Knowledge and Online Teaching Skills

Related MPTK components	Online teaching skills	Skill description
Mathematical knowledge of teaching	Subject matter knowledge	<ul style="list-style-type: none"> • express and master extensive content knowledge • develop course components and elements • link the subject with other relevant content and phenomena
	Pedagogical content knowledge	<ul style="list-style-type: none"> • implement instructional strategies, classroom assessment, and student engagement techniques • facilitate students' participation, provide guidance and support • organise assessment to evaluate students' performance • encourage knowledge construction based on students' past knowledge and experience • promote group interaction, collaboration, and teamwork
		Design skills <ul style="list-style-type: none"> • organise and present learning materials in different representations • design learning activities • select tools and techniques to present the activities
		Management and institutional skills <ul style="list-style-type: none"> • clarify the roles and expectations of the teacher and students • manage the lesson time • demonstrate leadership, management, mentoring and coaching skills, knowledge of administrative qualities and procedures • establish rules and regulations for participants and work submission • maintain contact with students

(continued)

Related MPTK components	Online teaching skills	Skill description
	Social and communication skills	<ul style="list-style-type: none">• request information and ask questions• clarify the purpose and meaning of messages and feedback• emphasise the important points• detect typographical and grammatical errors• use different communication methods to ensure accessibility among students• resolve conflicts and misunderstandings
Technology instrumental genesis	Technological skills	<ul style="list-style-type: none">• offer advice and suggestions• access various technological resources and tools• understand the capabilities and limitations of tools• aware of the procedures used to create content online• alert to latest updates of technology and software

Knowing a subject for teaching goes beyond knowing its facts and concepts (Shulman, 1986). Teachers must be able to explain why it is so and how it relates to other concepts. Subject matter knowledge is demonstrated in content skills that allow teachers to express their content knowledge and apply their knowledge to specific situations. Another knowledge unique to teaching is pedagogical content knowledge that bridges content knowledge and the practice of teaching (Shulman, 1986). According to Ball et al. (2008), pedagogical content knowledge combines knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum. Knowledge of content and teaching concerns the design of instruction, for example, implementing appropriate teaching and learning strategies, designing relevant learning materials, and sequencing a lesson based on given instructional time. These require teachers to possess pedagogical, design, and management and institutional skills. Knowledge of content and students refers to understanding what students are likely to think, for example, knowing students' errors and misconceptions. To understand students' thinking, teachers must interact with students, and this requires social and communication

skills. Teachers' technology instrumental genesis can be demonstrated in their technological skills. As suggested by Ratnayake et al. (2020), teaching mathematics requires teachers to convert technological tools into pedagogical instruments. In this regard, teachers need to be able to use various technological resources and tools, understand the capabilities and limitations of tools, be aware of the procedures used to create content online, and be alert to the latest updates of technology and software.

METHODOLOGY

This study consists of 202 respondents in which 53 percent were primary mathematics teachers and 47 percent were secondary mathematics teachers. A majority of the respondents (44%) had less than or equal to 10 years of mathematics teaching experience, 31 percent had teaching experience between 10 and 20 years, and another 25 percent had more than 20 years of experience. The teaching experience based on mathematics teachers' gender is shown in Table 2. At the time of undertaking this study, all the teacher respondents were conducting teaching of mathematics in online settings due to the pandemic public health measures.

Table 2

Teaching Experience based on Gender of Mathematics Teachers

Teaching experience (TE)	Primary school		Secondary school	
	Male	Female	Male	Female
TE ≤ 10	22	36	8	23
10 < TE < 20	9	20	5	28
TE ≥ 20	3	17	5	26

A survey design using an online questionnaire hosted on Google Form was employed in data collection. Respondents were recruited based on a combination of convenience sampling and snowball sampling (Cohen et al., 2017). These sampling techniques were used to ensure the recruited respondents possessed the desired criteria. In this regard, respondents were approached through the first and second authors' email communications and WhatsApp. The respondents were sent an invitation message containing a link to the survey and they were encouraged to share the link with other mathematics teachers. The

survey was opened for response between 1 and 17 June 2020. Note that the submission of the completed survey was accepted as an indication of the respondents' consent to participate in this study. A brief description of the study, including the purpose and the scope, was posted on the first page of the online survey. To keep the respondents fully engaged, the questionnaire was designed in a way which could be completed in 8–10 minutes. To address the research questions, data sources only focused on three items of the survey, which asked for responses to the following open questions: (1) What digital tools do you use to teach in the COVID-19 era; (2) What are the issues you encountered in your teaching in the COVID-19 era; and (3) What knowledge or teaching skills do you need to improve in the COVID-19 era?

Data Analysis

The three items above gathered a large amount of written text. Following the thematic analysis method described by Braun and Clarke (2006), the data were analysed to identify digital education tools used, issues of teaching faced by mathematics teachers, and mathematics teachers' perspectives about knowledge or skills of teaching that need to be improved during the pandemic. To analyse the collected data, initial codes were generated through reading and re-reading the data both in Malay and English. Similar codes were grouped and redundant codes were removed. Rigorous discussions between the researchers guided by related literature reviewed in the previous sections of this paper resulted in the categorisation of codes into several themes. The final codes and themes are condensed and explained in the following sections. Furthermore, descriptive statistics were utilised to answer the three research questions. Some of the teacher respondents' responses were included in this paper and marked as "T" followed with a number, for example, T1 represents teacher respondent number 1.

Classifying Digital Education Tools Used by Mathematics Teachers during School Closures

Respondents were asked about the digital education tools they implemented during the pandemic. The initial analysis of the digital education tools used when teaching mathematics yielded 232 digital education tools. Based on the names of the digital education tools, the tools were further categorised into 16 codes, each representing 16 distinctive groups of digital education tools. These tools consisted of WhatsApp, YouTube, Google Classroom, homemade videos,

Google Form, Telegram, Google Meet, Quizizz, PowerPoint, Zoom, Wordwall, Microsoft Whiteboard, Kahoot, Desmos graph, GeoGebra, and Skype. It is worthy to note that there was a group of responses referring to non-digital education tools, which were textbooks and exercise books.

Classifying Issues of Teaching Faced by Mathematics Teachers during School Closures

Respondents were required to list out a minimum of one issue they faced with teaching in response to the pandemic public health measures. The item examining the issues of teaching yielded 220 relevant responses. The 220 issues of teaching were analysed and resulted in 57 different codes. These codes were categorised into seven themes as summarised in Table 3. Note that there were respondents who responded “Nothing” [T26] or “No” [T171], indicating they had no difficulty in carrying out their teaching during the pandemic. This kind of responses were not grouped into the seven themes.

Table 3

Themes for Issues of Teaching Faced by Mathematics Teachers during School Closures

Themes	Codes of issues of teaching	Examples
1. Teachers' lack of technology ability	ICT/informative technology to teach; prepare digital content/electronic materials; web-based teaching; using computers/laptops/online platforms; e-book; use of social media	<ul style="list-style-type: none">• “Challenges in the use of ICT to teach” [T147]• “Teachers’ ability in using online platforms” [T19]
2. Students' lack of technology ability	ICT; learning online; using technology/learning platforms/Google Classroom (GC)/internet	<ul style="list-style-type: none">• “Students do not know how to respond using technologies” [T32]• “Issue of students’ difficulties in using Google Classroom, internet, ICT” [T131]

(continued)

Themes	Codes of issues of teaching	Examples
3. Internet problem	No/uneven/slow internet; internet is not stable; inadequate internet data; no internet quota; no access to the web; limited internet connection; connectivity to internet; loading net	<ul style="list-style-type: none"> • “No internet access” [T105] • “Connectivity to internet is not stable and weak” [T188]
4. No device	Inadequate computers/laptops; no smart device/handphone; lack of device; shared computers; no online facilities	<ul style="list-style-type: none"> • “Not all students have smart device facilities” [T168] • “There is a lack of device among students to access the internet” [T27]
5. Students’ engagement	Do not care; do not participate; less engagement; missing; not active; lack focus; unfollow instructions; not interested; no interest; less participation	<ul style="list-style-type: none"> • “Students do not care with online learning” [T8] • “Not participating in activities or discussions” [T182]
6. Methods of assessment	Check/test/measure students’ understanding; assessing students’ achievement; evaluate progress; marking work; judging unit performance; determine mastery/level	<ul style="list-style-type: none"> • “Unable to check students’ understanding” [T156] • “Issue with assessing students’ achievement” [T134]
7. Lacking parents’ support	No parents’ cooperation; slow response rate; no response from parents; parents not following instructions; lack collaboration	<ul style="list-style-type: none"> • “No response received from parents after sending materials to their handphones” [T101] • “The problem of parents not following instructions” [T4]

Classifying Knowledge and Teaching Skills Needed to be Improved during School Closures

There were 189 relevant responses collected on the knowledge and teaching skills that need to be improved during the pandemic. Since

the majority of the teacher respondents referred to teaching skills, this study classified all the responses of this item based on mathematics teaching skills as presented in Table 1. The teaching skills were grouped into 42 codes, simplifying them into six themes as summarised in Table 4. The descriptions of these themes are presented in Table 1. There were responses such as “Nothing” [T169] or “Nothing at the moment” [T6], indicating none of the teachers’ skills required improvement and these responses were not categorised into the six themes. There were also irrelevant responses, such as “Parents’ understanding of the importance of making sure their children learn” [T172] and “Solve students’ internet issue” [T195], and these responses were not grouped in any of the themes.

Table 4

Themes of Teaching Skills Needed to be Improved When Teaching during School Closures

Themes	Examples
1. Content skills	<ul style="list-style-type: none">• “Basic concept [serves a] stronger base” [T12]• “Fundamental skills of mathematics” [T87]
2. Pedagogical skills	<ul style="list-style-type: none">• “Learning and teaching [with] fun skills” [T152]• “Diversify methods of virtual teaching so that students do not feel bored with the same method every week” [T84]
3. Design skills	<ul style="list-style-type: none">• “Various planning skills” [T64]• “Systematic and efficient arrangement of teaching content” [T44]
4. Management and institutional skills	<ul style="list-style-type: none">• “Time which is limited” [T95]
5. Social and communication skills	<ul style="list-style-type: none">• “Communication” [T85]• “Direct interaction between teacher and students” [T51]

(continued)

Themes	Examples
6. Technological skills	<ul style="list-style-type: none"> • “Skills in mastering technology and applications” [T199] • “ICT, mathematics-related software” [T164]

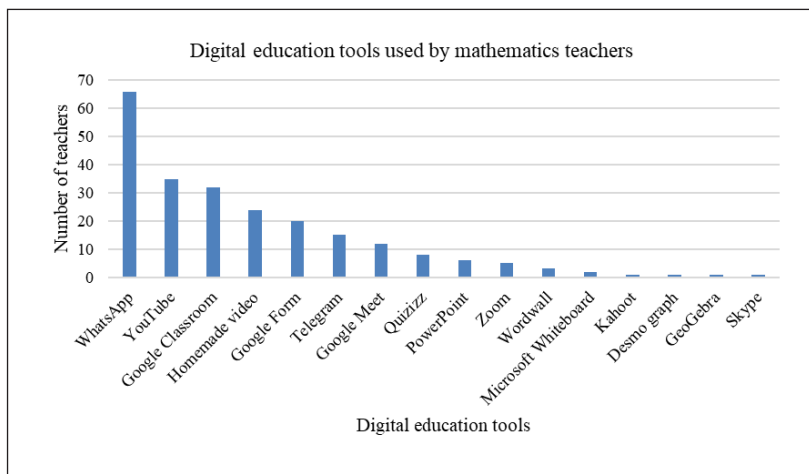
RESULTS AND DISCUSSIONS

Digital Education Tools used by Mathematics Teachers during School Closures

The analysis of digital education tools used by mathematics teachers during school closures yielded 16 digital education tools (see Figure 2). The most commonly used tool was WhatsApp. YouTube ranked second and Google Classroom ranked third. A substantial number of the teacher respondents employed pre-recorded homemade video clips, Google Form, Telegram, and Google Meet. A small group of them used PowerPoint, Zoom, Wordwall, and Microsoft Whiteboard. Kahoot, Desmos graph, GeoGebra, and Skype were the least popular tools among all. An analysis of the responses also found 19 responses that referred to non-digital education tools, which were textbooks and exercise books.

Figure 2

Frequency of Digital Education Tools Used by Mathematics Teachers



The result suggested that this group of mathematics teachers predominantly used WhatsApp, Google Form, and YouTube. Nevertheless, both the studies of Drijvers et al. (2020) and (Bergdahl & Nouri, 2020) found that their teachers focused mainly on using video conferencing software, such as Google Classroom and Google Meet. A possible explanation for this difference is that the teachers in this study might have experienced poor access of the internet and software crashing due to too many people using the video conferencing platforms at the same time (Bakker & Wagner, 2020). This explanation has been supported by the fact that the top issue faced by the teachers in this study was internet access. A teacher in this study, for example, expressed “I only send materials to students through WhatsApp because the internet service is poor and unstable” [T111]. Although WhatsApp may support self-directed learning and allow active engagement in learning, Annamalai (2018) highlighted that teachers have to keep interacting with students and scaffolding their learning.

In terms of Google Classroom usage as a digital education tool in teaching mathematics remotely, the present study reported that Google Classroom ranked third among the 16 identified tools. However, the study of Izhar et al. (2021) claimed that Google Classroom was one of the most used online teaching platforms in Malaysia. The difference in the finding is most likely due to the fact that Izhar et al. (2021) placed the focus only on the use of Google Classroom, but the present study compared it with various digital education tools.

On top of that, this study had a salient result that showed some teachers used only textbooks and exercise books to teach mathematics. Teachers had limited teaching materials at home when the government imposed sudden school closures. Consistent with Selvanathan et al. (2020), it is likely the teachers or students were lacking digital devices to access online materials, or they were having problems in accessing online learning platforms.

Issues of Teaching Faced by Mathematics Teachers during School Closures

Table 5 presents the data about issues of teaching encountered by mathematics teachers during the pandemic. The analysis indicated that the top issue was the internet problem (36%). About a quarter of the respondents were concerned with the students’ engagement in online learning. Both issues concerning teachers’ lack of technology ability and students’ limited access to any devices to access online

learning each constituted to about 12 percent. A small group of respondents referred to the methods of assessment, students' lack of ability in using technology, and limited parents' support. Only three respondents declared that they faced no issues in delivering teaching during school closures.

Table 5

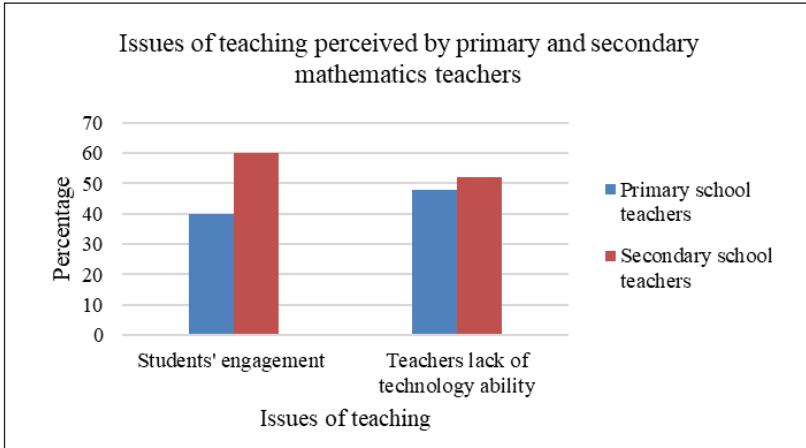
Data about Issues of Teaching Faced by Mathematics Teachers

Issues	Number of respondents	%
Teachers' lack of technology ability	27	12
Students' lack of technology ability	8	4
Internet problem	80	36
No device	27	12
Students' engagement	55	25
Methods of assessment	15	7
Lacking parents' support	8	4

Subsequent analysis was performed for the top three issues because they contributed significantly to the total number of issues faced by mathematics teachers. However, as internet connectivity and the problem related to students having no device to access online learning can be deemed as beyond teachers' control, the analysis focused on students' engagement to online learning and teachers' ability in using technologies. Of the 55 responses collected on the issue of students' engagement, 60 percent of the responses derived from secondary school teachers, meanwhile 40 percent from primary school teachers (see Figure 3). As for the 27 responses gathered for the problem related to teachers' lack ability in using technologies, both primary and secondary school teachers contributed almost equally to this response (see Figure 3).

Figure 3

Issues of Teaching Perceived by Different Levels of Mathematics Teachers



As revealed in the analysis, internet connection has been identified as the main barrier for conducting synchronous virtual teaching in Malaysia during the pandemic. This result is consistent with the study of Mailizar et al. (2008) in which they also concluded that access to internet connection affected online learning implementation. Not only that, Bergdahl and Nouri (2020) further reported that unstable applications or connections in Sweden had created problems for online learning. Another issue worth noting points to the methods of assessing students' performance. Although many teachers in the study of Bergdahl and Nouri (2020) indicated difficulties in determining assessment methods to evaluate students' learning, only a small number of mathematics teachers in this study were concerned about this issue. It is likely that the assessment method used by the teachers in this study emphasised mainly on executing algorithms and procedures. This speculation is consistent with the results of Drijvers et al. (2020) study, whereby their study demonstrated that the assessment methods implemented by mathematics teachers during school closures emphasised performing calculations and following mathematical rules.

The analysis showed that issues related to students' engagement during online learning was more commonly observed by secondary school teachers instead of primary school teachers. It is speculated that a lack of support and motivation could be faced by secondary

school students that prohibited them from keeping the schedule and tasks on track. A lack of interesting and effective learning materials and approaches might be a contributing factor for this phenomenon (Huang et al., 2020). As a result, secondary school students tended to slack off and appeared to be undisciplined towards their learning. In terms of lacking technology ability, almost an equal number of both primary and secondary school teachers were bothered by this issue. The teachers, regardless of their levels of teaching, encountered problems in setting up and operating the online platforms and this may be due to a lack of experience and skills in using technologies for educational purposes as argued by Mailizar et al. (2020).

Knowledge and Teaching Skills Needed to be Improved during School Closures

Among the 189 collected responses, more than half (52%) emphasised on technological skills. In contrast, only one respondent was concerned with management and institutional skills, while another seven regarded social and communication skills. As Table 6 suggests, 29 percent, 8 percent, and 6 percent of the respondents preferred pedagogical skills, content skills, and design skills, respectively. Another three respondents responded that none of the aspects required improvement.

Table 6

Descriptive Data about Teaching Skills Needed to be Improved

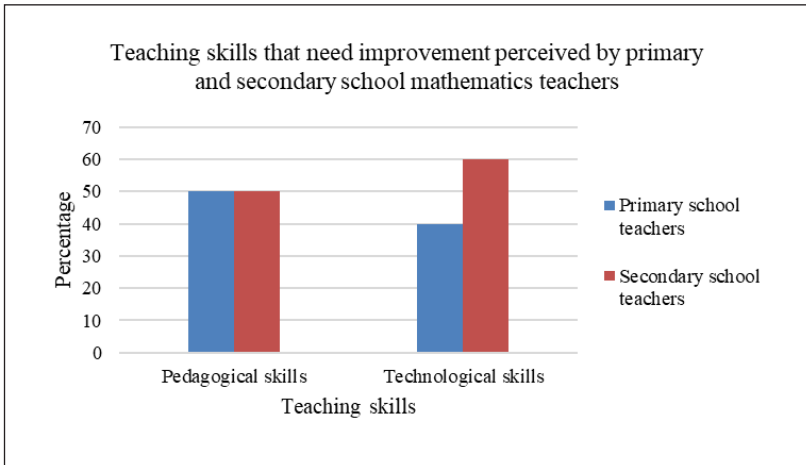
Teaching skills	Number of respondents	%
Content skills	16	8
Pedagogical skills	56	29
Design skills	11	6
Management and institutional skills	1	1
Social and communication skills	7	4
Technological skills	98	52

The analysis showed that both technological and pedagogical skills received prominent concern from the respondents. To better

understand these two teaching skills that required improvement, the subsequent analysis provided an insight into which level of teachers was more concerned regarding these skills. As compared to primary school teachers, more secondary school teachers (approximately 60%) felt that extra efforts were needed to further improve their technological skills (see Figure 4). However, as illustrated in Figure 4, an equal number of responses was received from both the primary and secondary school teachers regarding the need to enhance their pedagogical skills.

Figure 4

Teaching Skills That Need Improvement as Perceived by Different Levels of Mathematics Teachers



Most mathematics teachers expressed their technological concerns, particularly in using digital education tools. As illustrated in the MPTK framework, teachers need to incorporate the subtleties of digital education tools usage as pedagogical instruments. In this respect, teachers require strong technology instrumental genesis to operate online teaching. Many teachers are not technology savvy; however due to the pandemic, they are forced to learn and use a myriad of online platforms to sustain education. Therefore, they firstly need to improve their knowledge on technology usage before developing their technical skills in conducting virtual teaching practices. It is not a must for teachers to be technologically advanced; nevertheless, they need to acquire adequate technological knowledge and skills in accessing digital education tools and creating online materials (Albrahim, 2020).

As compared to primary school teachers, a greater number of secondary school teachers indicated that they needed to enhance their skills in utilising technology in a competent manner. Another knowledge that needs to be improved is pedagogical content knowledge that matters most in the teaching profession (Shulman, 1986). A significant number of teachers in this study were discontented with their pedagogical skills. Regardless of which levels they were teaching, they anticipated to broaden their instructional strategies and student engagement techniques. A teacher in this study, for example, explained that “Diversify the methods of virtual teaching so that students do not feel bored with the same teaching method every week” [T84].

CONCLUSION

Conclusively, the present study pioneered and represented the first research effort to examine the teaching performed by mathematics teachers in Malaysia due to the COVID-19 outbreak. This study contributed to an understanding of the digital education tools employed by mathematics teachers during school closures. Mathematics teachers of this study used a variety of digital education tools during school closures to teach mathematics. They have predominantly used WhatsApp, YouTube, and Google Classroom. It would be fruitful if future studies could reflect whether the tools were used as delivery tools, teaching tools, or additional tools during remote teaching; and further analyse the reasons for choosing the tools.

Several teaching issues faced by mathematics teachers were also identified in this study. The teachers’ geographical location is acknowledged as the prompting factor that might affect the problems they encountered during remote teaching; however, this study did not collect such data. Therefore, future studies may examine this gap. Rewardingly, this study found that more secondary mathematics teachers than those in primary schools were facing with the issue related to students’ engagement and intended to improve their technological skills. As this study lacks the kind of data that could specify the reasons for these phenomena, it deserves further research. Investigation on whether there are improvements on the problems encountered such as internet accessibility can be further analysed to achieve effective teaching and learning of mathematics.

Additionally, this study clarified the understanding of the knowledge and teaching skills that required further enhancements among mathematics teachers to sustain schooling in times of crisis. Half of the teacher sample desired to enhance their technological skills. This area of analysis can be extended by investigating the current preparedness among teachers in teaching mathematics, particularly their proficiency in using digital education tools.

This study, however, is not without shortcomings. As the respondents of this study were Malaysian teachers, teachers from other Asian, European, and American cultures may have different perspectives and views regarding teaching and learning in times of school closures. Whether or not the findings in this study are applicable to other countries merit future research. Although this study started at the beginning of the COVID-19 outbreak and the current situation may have changed, the results of this study are still relevant for improvement of mathematics teachers in dealing with online teaching and learning. In this extraordinary and unprecedented situation, teachers' preparedness for teaching virtually is very much needed. Therefore, the experience and reflections gathered in this study may serve as a strong guideline for future school closures.

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