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Perceptions of Malaysian University Mathematics Instructors of the Challenges they Face in Implementing Effective Distance Learning

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Abstract. Mathematics lecturers face various difficulties in implementing effective distance learning such as the lecturer's motivation in an online class. This research aims to explore the challenges encountered by lecturers when implementing effective distance learning. A qualitative case study approach was used to explore issues regarding effective distance learning in Higher Education Institutions (HEIs). Eight mathematics lecturers from three different institutions were chosen to be the participants using purposive sampling. The participants consisted of five lecturers from Kolej Matrikulasi Negeri Sembilan (KMNS), two lecturers from Kolej Matrikulasi Pulau Pinang (KMPP), and one lecturer from Universiti Kebangsaan Malaysia (UKM). The research data was collected through semi-structured interviews followed by field notes. Thematic analysis techniques were used to identify the constructs, themes and patterns present using the NVivo software. The interview findings highlighted six main themes, specifically the students' engagement and motivation, lack of communication, lack of immediate feedback, difficulty when demonstrating and in visualisation, developing the learning materials and limited internet connectivity. Lecturers may consider incorporating engaging activities to keep students interested throughout the lesson. Additionally, backup plans should be developed to address issues related to internet connectivity, which can disrupt the teaching and learning process.

Keywords: distance learning; challenges; Mathematics; lecturers difficulties

1. Introduction

Distance learning has revolutionised the field of mathematics education, providing students with the flexibility to engage with mathematical concepts and skills remotely. Recent advancements in technology and online platforms have

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further enhanced the effectiveness and accessibility of distance learning in mathematics. In the digital age, distance learning in mathematics has gained significant momentum, allowing students to transcend the limitations of traditional classroom settings. Almarashdi and Jarrah (2021) stated that distance learning has emerged as a transformative force in mathematics education, enabling learners to access high-quality instructional resources, collaborate with peers, and engage in interactive mathematical activities, irrespective of geographical constraints.

A key area of focus in the recent research on distance learning in mathematics is the integration of adaptive learning technologies. These technologies can personalise instruction and provide individualised support to students based on their unique learning needs. Walkington (2013) highlighted the impact of adaptive learning systems, stating that the integration of adaptive technologies in distance learning platforms has shown promising results in promoting student engagement, improving mathematical performance and fostering a deeper understanding of mathematical concepts.

Moreover, distance learning in mathematics offers diverse opportunities for collaborative learning and peer interaction. Virtual classrooms, discussion boards and online collaboration tools facilitate meaningful mathematical discourse and problem-solving activities among students. Hsu and Shiue (2018) emphasised the significance of collaboration in distance learning, stating that online mathematics courses that foster collaborative learning environments enhance the students' mathematical reasoning abilities, promote critical thinking and encourage the exploration of multiple solution strategies.

Furthermore, the existence of mathematics lecturers in the virtual classroom is instrumental in fostering a sense of community and belonging among students. Building on the work of Oztok and Brett (2011) who emphasised the importance of social presence in distance learning, mathematics lecturers use various communication tools and strategies to create a supportive and collaborative learning environment. Through online forums, video conferences and personalised feedback, lecturers foster connections among students, promoting peer-to-peer learning and the sharing of mathematical insights.

However, the implementation of distance learning in mathematics education has brought about significant changes in the role of mathematics lecturers. As they navigate the virtual landscape, they encounter unique challenges in ensuring effective teaching and learning experiences for their students. They must navigate the use of educational technology, foster student engagement and motivation, and provide meaningful support and feedback to students in remote environments. By addressing these challenges, mathematics lecturers can create engaging and impactful distance learning experiences that promote students' mathematical learning and success.

Due to significant changes in the role of mathematics lecturers, the research question look into what challenges are faced by mathematics lecturers in

implementing effective distance learning. This research focuses on the challenges faced by mathematics lecturers in distance learning environments and examines the evolving landscape of mathematics education from their perspective. By delving into the experiences, strategies and best practices of mathematics educators in the virtual realm, we aim to shed light on the transformative potential of distance learning and its impact on teaching practices. Besides, this article will serve as a platform to explore the possibilities, opportunities and challenges that lie ahead, paving the way for a new era of mathematics education that embraces the virtual realm and empowers learners to unlock their full mathematical potential.

2. Literature Review

Bååth (1981) emphasised the significance of the physical separation between teachers and students as a crucial aspect of distance learning. In this approach, education occurs within the framework of educational institutions employing social media for communication between teachers and students. Face-to-face meetings are possible, and the education industry model is employed. However, the definition of distance learning in mathematics varies based on the perspectives of educators and reflects the educational culture of each country and Higher Educational Institutions (HEI) (Fidalgo et al., 2020). In this study, the researcher adopted Keegan and Papiere's (2002) definition of distance learning in mathematics. Hence, distance learning in mathematics refers to an educational experience where the teacher and students are separated in time and space. As a result, distance learning in mathematics can take place outside academic institutions and can lead to academic degrees or qualifications (Jonassen et al., 2008). Although there are diverse forms of distance learning in mathematics, this study specifically investigates online distance learning in mathematics.

Due to the widespread accessibility of information and educational resources through the World Wide Web (WWW), distance learning in mathematics has been propelled into the digital era. This shift has been facilitated by the WWW, which has enabled people around the globe to access educational content. Consequently, distance learning in HEIs has gained popularity worldwide (Allen & Seaman, 2017). However, some HEIs have not embraced this approach for cultural reasons. The Coronavirus Disease 2019 (COVID-19) pandemic has had a transformative impact on teaching and learning methods today (Ali & Ishak, 2020). In response to the pandemic, schools and HEIs in nearly 200 countries were closed, affecting over 90% of students across all levels of education (UNESCO, 2020). The educational sector, like other sectors, was entirely shut down due to the spread of COVID-19 (Awofala et al., 2020). As a result, students were unable to physically attend school and were required to study from home.

Consequently, distance learning in mathematics serves to maintain uninterrupted student education during the COVID-19 pandemic. Different educational tools and platforms, including YouTube, Learning Management Systems (LMS), digital libraries, internet streaming, broadcasting and repositories like Open Educational Resources have been utilised based on their accessibility in specific countries. Moreover, HEIs have adopted online platforms like Zoom and Google Hangouts.

Simultaneously, lecturers are encouraged to leverage various websites such as Facebook, WhatsApp and Google Forms.

As lecturers transition to an online setting, they face a broader range of issues that require their attention. The online environment functions as a learning network, where students collaborate to construct and share knowledge. Consequently, the teaching methods employed in face-to-face or traditional maths classrooms may no longer be applicable or feasible in a distance learning context. Moreover, lecturers must acquire new skills, behaviours and strategies to effectively tackle the challenges specific to the online environment and navigate unfamiliar problems. These challenges encompass proficiency in using software packages, the ability to cultivate competence in teaching and learning maths online, and the emotional adjustments required when working in a virtual environment that differs from a conventional teaching setting. Hence, it is undeniable that lecturers play a crucial role in ensuring the success of mathematics education in an online learning environment. This is because, in such a setting, lecturers assume a more vital role in overcoming the potential obstacles arising from technology, time constraints and geographical limitations.

Furthermore, in face-to-face instruction, the lecturer assumes the responsibility of maintaining a balance in terms of the students' comprehension, ensuring their understanding aligns with the topic, and enabling them to apply their knowledge and problem-solving techniques. Consequently, lecturers encounter greater obstacles when students are physically distant, as they are unable to provide direct guidance. The conventional teaching approach allows lecturers to promptly redirect the discussion if students deviate from the intended subject. Conversely, in online teaching, the interaction between lecturers and students transpires with a time delay and a lack of synchronicity. Consequently, lecturers are ill-prepared to steer the discussion back on track. Students may wander off without the lecturer's awareness and prematurely end the learning session. According to Romiszowski's (2013) findings derived from an extensive literature review and personal experience, regaining the students' attention and refocusing the discussion on to its original objective is more challenging in asynchronous interactions compared to face-to-face discussions. Therefore, enhancing the competence of online lecturers, who play a vital role in fostering and facilitating interactivity among distance learners, holds significant potential for substantial improvements in delivering online mathematics education.

Assessing the students' academic performance and achievement in mathematics has become a challenging task for lecturers. At the level of HEIs, the assessment process serves three primary objectives: (1) facilitating learning, (2) ensuring accountability, and (3) providing certification, progress tracking, and transferability (Archer, 2017). Additionally, in the context of mathematics education at the tertiary level, both formative and summative assessments, accompanied by appropriate feedback mechanisms, are employed to support the learning process. This entails using assessment data in a diagnostic manner to identify the students' competencies, areas for improvement, and overall progress, enabling students to adapt their learning strategies while allowing lecturers to

adjust their teaching approaches accordingly. The use of assessment for accountability purposes serves as tangible evidence of ongoing learning (Guangul et al., 2020). Furthermore, as noted by Archer (2017), assessments can also serve the purpose of certification, ensuring progress and facilitating the successful transfer of knowledge and skills.

Many researchers have identified the various challenges faced by mathematics lecturers when implementing online distance learning (Alea et al., 2020; Almaiah et al., 2020; Fauzi & Sastra Khusuma, 2020; Mohalik & Sahoo, 2020; Nambiar, 2020; Rasmitadila et al., 2020). This is primarily due to the sudden shift from traditional face-to-face teaching to fully online teaching methods. Research conducted by Alea et al. (2020) revealed that the distance learning approach in mathematics hinders effective two-way communication between lecturers and students, consequently impeding the achievement of the teaching objectives. Consequently, lecturers encounter difficulties in establishing active communication with students, while the students' motivation to actively participate in online learning sessions also poses a significant challenge to the successful implementation of effective distance learning in mathematics. As a result, these limitations contribute to the failure to achieve effective outcomes in the distance learning of mathematics.

Competence encompasses the capacity derived from an individual's expertise, abilities, attributes, and mindset to effectively carry out tasks and achieve the desired outcomes (Kopaiboon et al., 2014). Competence comprises knowledge, skills and attitudes. Knowledge refers to the information acquired by a student in a classroom or through practical training, influenced by experience and their comprehension of specific subjects. Skills entail using knowledge to perform tasks appropriately and accurately while meeting established standards. Attitude pertains to an individual's disposition, emotions or internal traits that demonstrate awareness of the benefits and values associated with something. Therefore, to effectively implement distance learning in mathematics, HEIs need guidelines that identify the necessary competencies for ensuring the success of distance learning in this field.

The majority of activities in HEIs, such as applying for admission, registering for courses, managing courses, taking e-examinations, reviewing results and making fee payments, are heavily reliant on technology (Amini & Oluyide, 2020). Consequently, it can be presumed that students are expected to use technology in their learning process. They must acquire the necessary digital skills that are crucial for their personal, professional and societal contributions. These digital skills encompass creativity, innovation, communication, collaboration, interactivity, information fluency, decision-making, critical thinking, problem-solving and proficiency in using technology. Numerous initiatives have been implemented to create a supportive digital environment that aids students and lecturers in the field of education at HEIs (Agyeman, 2007). Consequently, the digital skills possessed by educators are considered instrumental in enhancing the effectiveness of distance learning in the field of mathematics.

The effectiveness of distance learning mathematics is also influenced by the lecturer's expertise in both content and pedagogy. This is because the knowledge of content and pedagogy encompasses a range of complex knowledge, including a deep understanding of the subject matter and effective instructional strategies (Shulman, 1987). According to Shulman (1987), a lecturer possesses the capacity to adapt the teaching methods to suit the student's needs based on their knowledge. Hence, the lecturer's grasp of the content and pedagogic knowledge involves the ability to identify the abilities of their students. Therefore, it can be concluded that mastery of content and pedagogy, along with effective delivery strategies by lecturers, plays a crucial role in ensuring the success of distance learning in mathematics.

Active two-way communication between lecturers and students contributes to the advancement of mathematics distance learning (Saxena et al., 2021). Multiple studies have proposed a definition for interaction in online learning (Azmat & Ahmad, 2022). Commonly, interaction in online learning encompasses three types: lecturer-student, student-lecturer and student-content. Consequently, interaction refers to the process of exchanging meaningful information and ideas among two or more individuals (Tu & Cory, 2002). Various studies have been conducted to enhance student interaction with lecturers in different learning scenarios (Azmat & Ahmad, 2022). While collaboration benefits from interaction, being a quiet student can also positively impact other online students. Moreover, interaction and conversation have long been crucial components of higher education (Zhang et al., 2004). In online learning communities, social connections hold great significance. Interaction lies at the core of the learning process and plays a vital role in achieving favourable student learning outcomes. It promotes knowledge development and student empowerment, and provides a platform for community members to express their perspectives and interests (Rapanta et al., 2020).

3. Methodology

The researchers used a qualitative case study approach with interviews chosen as the method of data collection. This was done because the researchers wanted to explore the actual challenges faced by mathematics lecturers in implementing distance mathematics education (Yin, 2014; Baxter & Jack, 2015). Additionally, with qualitative research being open-ended, it allowed the researchers to actively communicate with the study participants and delve into the issues being examined realistically and accurately (Baxter & Jack, 2015; Merriam & Tisdell, 2016). Furthermore, the researchers conducted a multi-site case study. Based on the researchers' objectives, the multi-site case study referred to the implementation of distance mathematics learning in three HEIs in Malaysia which are KMNS, KMPP and UKM. This approach allows researchers to compare and contrast findings across the different sites, enhancing the understanding of the issues (Yin, 2018). Therefore, the researchers were able to immerse themselves in and understand the real issues in the study, even though it involved a small number of study participants (Noraini, 2010)

The study locations involved three HEIs in Malaysia, including a matriculation college and a university through purposive sampling. The selection of multiple locations for HEIs allowed the researchers to observe the implementation of distance mathematics education from different perspectives. The participants in this study consisted of mathematics lecturers who taught mathematics subjects at the higher education level, including the pre-university and bachelor degree levels in Malaysia. The researchers selected eight study participants from three institutions using purposive sampling. A total of eight participants in the study was determined to be sufficient. According to Creswell and Poth (2017), a small number of study participants is adequate to allow researchers to explore an issue in depth as the sample participants should be determined by informational needs. The participants were selected based on their teaching experience, willingness to share valuable information, and their involvement in structuring the content of mathematics distance learning. Therefore, the selected study participants were chosen based on their experience of mathematics teaching during the COVID-19 pandemic.

The interview method was used as the primary method of data collection in this study, followed by field notes. To be precise, the researchers conducted semi-structured interviews, which allowed them to explore and understand the participants' experiences and generate unique data (Patten, 2018), providing flexibility in questioning (Brinkmann & Kvale, 2019), facilitating the collection of rich data (Rubin & Rubin, 2012) and offering a versatile approach to the data collection compared with other data collection instruments. Furthermore, the interviews in this study were conducted online. In this process, the researchers scheduled interviews with the study participants and informed them about the study objectives and interviews, the duration of the interviews, and the recording of the sessions. The data analysis process ran concurrently. The data obtained from the interviews included interview transcripts, audio recordings and field notes. The researcher used thematic analysis techniques to search for constructs, themes and relevant patterns using the NVivo software.

In qualitative research, the researcher usually serves as the data collector and data analyst, which carries the potential for researcher bias. This is because researchers may impose their personal beliefs and interests at all stages of the research process, leading to the dominance of the researcher's voice over that of the participants (Creswell & Miller, 2000). However, the potential for researcher bias can be reduced by actively involving the research participants in reviewing and validating the findings. According to Birt et al. (2016), the method of returning interviews or analysed data to the participants is known as member checking, respondent validation or participant validation. Member checking is used to validate the qualitative findings or assess the reliability of said findings. Therefore, the researcher presents interpretations and descriptions based on the researcher's understanding to the participants as a way to obtain validity and agreement from them (Birt et al., 2016).

4. Findings

Based on the interview data, six main themes were obtained by the researchers regarding the challenges faced by lecturers when implementing effective distance learning in mathematics. The themes are student engagement and motivation, lack of communication, lack of immediate feedback, difficulty in demonstrating and visualisation, designing the learning materials and limited internet connectivity. The themes are explained as follows.

1) Students' Engagement and Motivation

Based on the findings, one of the challenges faced by the lecturers was inspiring and engaging the students throughout the virtual lessons. Lecturer E stated that

> "*...in lecture, there are more than 30 students, so it's quite difficult to ensure that all the students are participating during the classes…*".

Maintaining the students' interest proved to be quite challenging due to the absence of in-person interaction, as well as the inability of the lecturers to observe the students' reactions during the class as stated by Lecturer F.

> *Lecturer F: …it's difficult because we don't meet face-to-face, so it's hard for us to know how the students are doing*

They encountered difficulties capturing and sustaining the students' interest during synchronous classes due to the inability to observe their gestures and nonverbal cues. Assessing the students' level of engagement throughout longer sessions or subjects involving calculations became more challenging without visual feedback.

> *Lecturer B: ...it is quite challenging because as a mathematics lecturer, I need to continuously engage students in discussions, especially when we can't see them directly. My teaching focuses more on calculations, so it requires discussion and analysis…*
>
> *Lecturer D: ...even during face-to-face classes, it was challenging… now we can't see the students, and they can't see us either so it's difficult to make sure students can solve the questions…*

Additionally, some students exhibited inattentiveness, particularly during synchronous classes. To keep the students engaged in activities and to ensure their active participation in discussions, lecturers had to employ interactive tasks. Lecturer A found it difficult to motivate students when it came to performance-based activities. Consequently, some students received low grades as they did not complete all the assigned tasks.

> *Lecturer A: ...the challenge of maintaining students' attention during discussions. I incorporate interactive activities to monitor their engagement...due to slow internet connections, students show signs of being less attentive during synchronous discussions…*
>
> *Lecturer B: ...maintaining student motivation is a significant challenge...Some students may receive low grades because they fail to complete all the given activities…so I need to add some fun activities during the session…*
>
> *Lecturer E: ...in online classes, we need to understand that it's difficult to focus 100% because many other factors influence it, and it will impact the*

student's performance…to cater to this problem, interactive tasks will be helpful…

A non-conducive student environment was also a cause for the lack of motivation during online learning. As a result, lecturers faced difficulties in ensuring that all students were at an optimum level of readiness, and making sure that they were prepared to learn. Some lecturers stated that the student environment affected their motivation to continue online learning.

Lecturer A: ... some students don't have suitable study spaces. Some use the hall, some use the place where they eat, some use the place where their siblings play, and so on. So, such situations disturb the students in continuing their studies…
Lecturer B: ...things like these are difficult for us to control. Besides, it was during the MCO, so everyone couldn't leave their homes. So those who didn't have suitable study spaces had to study anyway. Because they didn't have a choice...
Lecturer C: ... some students had to leave their homes to study. Even though it was during the MCO, they still went out to study. Because they said they were stressed with the noisy environment at home…

Some lecturers also stated that the students were burdened with household chores and this contributed to the students' emotional instability. Therefore, lecturers sought alternatives to reduce their students' stress and understand their situation. Lecturer A stated that they used surveys to understand the situations faced by students. Furthermore, the parents' perceptions also influenced the students' motivation to learn.

Lecturer A: ...we did ask the lecturers to survey the students so that we can know their situation, whether they have sufficient resources for online classes, if any obstacles are preventing them from attending class, how they are feeling, and so on…
Lecturer B: ... some students have to live with their grandparents because their homes are crowded with younger siblings, so their parents asked them to stay with their grandparents to cut costs. Yeah, previously they were staying in a college, so when the MCO was implemented and they had to return home, the burden on their families increased. So the students feel sad because they feel like a burden to their parents. Some even want to quit…
Lecturer C: ...when staying at home, the expectation to help with house chores is high. So, these students are stressed because there is a lot of work to be done, not to mention assignments. When they don't do the house chores, their parents get angry. The students also get angry because their parents don't understand their situation...

The lack of communication in mathematics distance learning presented significant challenges for both lecturers and students. Lecturers struggled to inspire and engage students throughout the virtual lessons due to the absence of face-to-face interactions and the inability to observe the students' reactions and nonverbal cues. Sustaining the students' interest during online classes became challenging without visual feedback. To overcome these issues, lecturers must

employ interactive tasks and activities to promote active participation and motivation. A non-conducive student environment caused a lack of student engagement and academic performance in online learning. The burden of household chores and emotional instability added to the challenges the students face, impacting their motivation and ability to focus on their studies. Lecturers actively sought alternatives to reduce their students' stress by understanding their situation and supporting their learning needs.

2) Lack of Communication

This difficulty was highlighted by several participants who expressed the inability to force students into engaging in discussions. Furthermore, there was limited interaction with students, and at times, students even disregarded the lecturers when called upon to answer or participate. Some students also turned off their cameras or claimed poor internet connectivity, leaving lecturers unaware of their activities during class.

> *Lecturer A: ...it is very challenging because students cannot be forced to participate in discussions... Some students ignore me when I ask them questions…*
> *Lecturer B: ...There are challenges in getting students to participate because we cannot see them physically. We don't know about their actions during the teaching process...*

Therefore, the lecturers used different approaches and alternatives to encourage student participation during the teaching of mathematics. This was because the lecturer needed to conduct active learning to ensure that students were engaged in the class and successfully achieved the learning objectives for the day. This was supported by several statements from the participants who had diversified their teaching techniques.

> *Lecturer A: ...5-10 minutes of teaching, then another 20 minutes for students to do the task, 10-15 minutes for students to do practice exercises, then another 5-10 minutes to explain the theory again, and then students need to do the task again. This is the concept of active learning.*
> *Lecturer C: ...usually in the middle of our lesson, we have to incorporate something like a game, you know, to make it more engaging for the students. It may seem childish, but actually, we can attract them by saying something like, "Oh, wait, my name is going up, right?" like that…*
>
> *Lecturer F: ...I will conduct an oral test during the tutorial. Because there aren't many students, it's not possible in a lecture, and it's not practical either...from there, we can see whether the student is attentive in class or just attending without any engagement.*

The low mastery of technology and discipline among students during virtual classes made it even more challenging for lecturers to ensure that the students were mastering the taught mathematical concepts. The study participants stated that students did not possess basic technological skills and lacked self-efficacy in learning. However, Lecturer A stated that students should be given more time and space to explore and build their self-efficacy.

> *Lecturer A: ...there are indeed students who have never or rarely used computers and all that. For example, some B40 students have never used smartphones and so it's something new for them... a lack of exposure to using it, so we need to understand them and give them space…*
>
> *Lecturer D: ... some students don't even know the basics of technology. They don't know how to make slides for presentations, they don't know how to search on Google, and they don't know anything. How are we supposed to teach them?*
>
> *Lecturer F: ...we are learning online for the first time, so there are students who don't know how to use the internet and all that, so it's difficult. Nowadays, with technology, you just search on that platform and you'll find all sorts of things. From there, you can already learn something new. If we have to teach everything, we will never finish our syllabus...*

The difficulties highlighted by the participants regarding the lack of student communication and engagement in mathematics distance learning showed that there were significant challenges faced by the lecturers. The inability to interact and communicate with students blocked the effectiveness of teaching. Additionally, the students' low mastery of technology and lack of self-efficacy further complicated the teaching process. To overcome these challenges, the participants employed various approaches and alternatives to encourage student participation and engagement. Active learning strategies, such as incorporating tasks, practice exercises and theory explanations, helped maintain the students' involvement throughout the lesson. Games or interactive elements were introduced to make the classes more interactive. In conclusion, addressing the lack of communication and engagement in mathematics distance learning required a combination of instructional strategies, technological support and an understanding of the students' backgrounds. Through these implementations, the participants could create an interactive learning environment that promoted active participation and mastery of the mathematical concepts.

3) Lack of Immediate Feedback

When it came to delivering lessons online, lecturers encountered additional difficulties in the subjects they taught. The immediate correction of assessments and timely feedback became challenging tasks.

> *Lecturer D: …I can't correct students' assessment or their mathematical concepts during the lecture as it will interrupt the whole class…the cognitive level of each student differs and it's hard to fit them all in one session…*

Furthermore, the lecturers faced limitations when supervising students while they work. The lecturers also expressed uncertainty regarding the students' learning progress since there was little verbal interaction. The classroom was extremely quiet, making it difficult for the lecturers to gauge whether the students were actively listening, understanding the lessons or facing challenges.

> *Lecturer C: ...I can't see the students' expressions while I'm teaching, making it difficult for me to determine whether they truly understand or not...everyone remains silent or takes time to respond…*
> *Lecturer E: ...usually, the students will turn off their cameras, and when we ask a question like "Does everyone understand?", no one says anything...they only speak up to say thank you, madam, haha…*
> *Lecturer F: ...there is a limit for us to know and see the student's progress in class...we also don't know whether they are listening to the lecture or sleeping while being online...*

This also occurred due to the lecturers still adapting and not fully mastering the online platform. The lecturers had to communicate outside of teaching hours to provide feedback to the students, and this required a high level of commitment. Some lecturers stated that they were still unable to conduct active teaching.

> *Lecturer B: ...because it's the first time using all these, so we're not familiar with those things. It's difficult for us who are already old…*
> *Lecturer C: ...I do require students to meet me outside of class. Yeah, if we want to correct and give them feedback on everything, there's no time in class. At matriculation, we need to speed up, and we have to follow the teaching plan…*
> *Lecturer E: ...I have to WhatsApp or Telegram the students to share with them what they got wrong and everything. It might be slow, but that's the only way I know and it's easy for me…*
> *Lecturer F: ...in lectures, it's usually one-way communication. Because we don't have time to know if the students understood or not. In tutorials, we can make sure that they understand because there aren't many students...*

Delivering lessons online presented additional challenges for the participants, especially when it came to assessing student performance and providing timely feedback. Furthermore, the absence of face-to-face interaction made it difficult for lecturers to supervise the students' progress and determine their level of understanding. Additionally, lecturers struggled with adapting to the online platforms and technologies, affecting their ability to deliver active teaching and engage with the students effectively. As a result, lecturers resorted to communication outside of teaching hours to provide feedback, often through messaging apps, which required a significant commitment of time and effort. Overall, the transition to online teaching necessitated continuous adaptation and posed significant challenges for lecturers in ensuring effective communication and student learning.

4) Difficulty in Demonstrating and Visualisation

Limited resources, both for teachers and students, presented additional obstacles in conveying topics effectively. This was especially true for subjects that involved problem-solving, as lecturers lacked tools like a Jamboard to freely demonstrate solutions as stated by Lecturer A.

> *Lecturer A: ...The inability to monitor opportunities and resource limitations poses challenges in delivering certain topics, especially those involving problem-solving…*

To ensure the students' comprehension, lecturers must exert significant effort and employ various teaching strategies that cater for different learning styles and modes.

> *Lecturer B: ...Maintaining student focus and ensuring their understanding requires significant effort...because they don't seem to know how to comprehend…*
> *Lecturer C: ...Mathematics is difficult for students to understand and perceive because it is more abstract…we need so-called tools to use in online lectures…*
> *Lecturer D: ...For subjects like maths, we can't just rely on verbal explanations. So we need tools like tablets to teach and allow students to see what we write...*

As a result, lecturers experienced doubts regarding the students' understanding when they did not actively participate in the activities. It was disheartening for lecturers when students showed a lack of interest in their studies and failed to appreciate the lecturers' efforts.

> *Lecturer B: …Teaching becomes very challenging, especially in subjects involving numbers, when communication with students is limited. Sometimes I am disappointed with the students' attitude…*
> *Lecturer C: It's sad because we try various methods to make the students understand. But after finishing the lesson, when we ask if they understand, they don't. It's stressful, but what can we do? We explain and show the work again…*
> *Lecturer F: It's important to understand that the impact of online learning is not the same as face-to-face learning. Studies may suggest that online learning has many benefits, but the reality is that it's difficult for us to make the students see and understand.*

The limited resources available to both teachers and students presented significant challenges in effectively conveying topics, particularly in subjects like mathematics that involve problem-solving. The absence of suitable tools for visual demonstrations blocked the teachers' ability to effectively teach and for the students to understand. The participants needed to exert significant effort and employ various teaching strategies that catered for different learning styles and modes to ensure the students' understanding. However, despite their best efforts, lecturers still faced doubts regarding understanding when active participation was lacking. This was frustrating for lecturers who invested time, money and energy in their teaching. It is crucial to recognise the difficulties of online learning and the need for additional support and resources to bridge the communication gap in mathematics distance learning.

5) Designing Learning Materials

Based on the findings, the participants developed a deeper understanding of a specific subject by effectively using appropriate learning resources. As stated by Lecturer B,

> *"...good materials and resources for students are essential for enhancing their knowledge of mathematical concepts.."*.

However, some participants stated that they faced a significant challenge preparing instructional materials suitable for online learning.

> *Lecturer E: …an older lecturer preferred to do the old-school ways with board and so on… they struggled to create suitable and interactive class materials that fit with students…*

As a result, they dedicated more time to creating PowerPoint presentations for synchronous and asynchronous classes and needed to adapt to the LMS being used. Additionally, they needed to use updated gadgets that were compatible with the LMS.

> *Lecturer F: …some of the software is not compatible with the old version of my laptop, so I need to pay for upgrading…*

Participants stated that during the initial implementation of online learning, lecturers had to adapt their instructional materials to suit digital instruction. One of the difficulties they faced was the significant amount of time required to create PowerPoint presentations for every lesson.

> *Lecturer C: …usually I just used the materials that were prepared by the mathematics department but now need to develop new materials and teaching techniques based on my students…*
> *Lecturer F: …need a longer time to create good materials. Plus, we need to ensure that it is relevant to our students…*

However, Lecturer A stated that the preparation of teaching materials was not a problem because some lecturers had already prepared with online materials.

> *Lecturer A: ...about 20% - 25% of lecturers are already prepared for online learning... we have recorded videos, we have used Canva, we created videos...*

Apart from that, the participants faced challenges creating digital modules and corresponding learning materials. The task of preparing instructional materials became demanding since everything had to be in a digital format.

> *Lecturer E: ...it's quite difficult as we need to prepare for both synchronous and asynchronous classes…need to make sure the content is relevant for the students…*

The participants also mentioned that due to online classes, lecturers had to ensure they had all the necessary learning materials for each module readily available. Additionally, Lecturer A highlighted the initial struggle lecturers faced while adapting to the new LMS.

> *Lecturer A: ...we need to teach our lecturers to use the LMS system... because they want to upload materials, but they don't know where to put them. So, they need to learn…*

From the above statement, the gadgets used in online classes were just as important as the learning materials used for delivering the lessons. Furthermore, the devices and applications needed to be compatible with Microsoft 365 to ensure seamless delivery of the online classes. This posed a challenge for lecturers, as they needed to update or replace their gadgets. Lecturer B emphasised the need

to acquire suitable tools and specifications within their budgetary limits. Moreover, the participants highlighted the importance of using a smartboard to write down equations during teaching.

> *Lecturer A: ...it's like a blackboard... it appears on the screen, right? So, we need a so-called board to facilitate teaching…*
> *Lecturer B: ...we need a smartboard. And then we need a suitable pen, right? Like in mathematics, we need a board because we want to write...*

Based on the findings, the importance of using appropriate learning resources for effective online learning in mathematics was significant. The challenges faced by lecturers in preparing instructional materials for online classes were crucial, as they needed to ensure relevant content for both synchronous and asynchronous classes. Moreover, the compatibility of gadgets was crucial for seamless online class delivery. However, it necessitated that lecturers updated or replaced their devices within their budgetary limitations. In conclusion, the ongoing support, training, and availability of suitable tools and devices could facilitate the transition to online teaching and improve the overall learning experience for both lecturers and students.

6) Limited Internet Connectivity

This study showed that the inconsistent availability of internet access negatively impacted the educational experience of students as most classes were conducted online and relied heavily on a stable and fast internet connection for synchronous learning.

> *Lecturer C: …students with poor internet connection will not be able to join live classes but they can watch the recorded video…*

Inadequate internet connectivity was identified as the primary challenge faced by both lecturers and students when it came to conducting online classes. As stated by Lecturer D

> *"...when lecturers or students encounter difficulties in establishing a connection, the entire learning process is put at risk…".*

This was because effective teaching and learning could only take place when there was a reliable connection between lecturers and students.

> *Lecturer F: ... the online platform linked students and lecturers during the teaching process…the internet helps in connecting people throughout the world…*

The participants encountered difficulties due to inadequate internet access, resulting in decreased student attendance as mentioned by Lecturer A.

> *Lecturer A: ... there was a meeting within the faculty, and there were lecturers who were dissatisfied with the students' attendance because the students did not attend the online classes…*

The participants stated that the surge in online activity during the pandemic was expected to cause disruptions in internet connections, which were beyond the control of lecturers. Insufficient or unreliable internet connectivity significantly hampered the continuity of lessons and led to poor student attendance. Students

often cited internet connectivity issues as a reason for their inability to complete assignments and engage in other activities.

> *Lecturer B: ..."Madam, I can't attend, I have device-sharing issues." It's fine, so what should we do? I posted what I've taught on the Google Site or posted it on Google Classroom so the student can access the materials…*
> *Lecturer F: ... some of my students told me that they can't even access the online platform like Google Classroom for example, so we need to find a way so that they also can get the input like their class members…so I ask them to submit the task through Telegram…*

An inconsistent internet connection posed a challenge during the implementation of online classes. Several participants highlighted this issue. This stresses the importance of patience from both lecturers and students when it comes to internet connectivity. As a result, they opted for asynchronous classes to avoid wasting time. They also encountered glitches and malfunctions in the Microsoft Teams platform itself, which hindered the smooth conduct of their online classes. Specifically, they mentioned that unstable internet connections and technical problems with Microsoft Teams posed obstacles to effective teaching.

> *Lecturer B: … the main problem we face is the internet connection...we need a better internet connection for smooth teaching…sometimes the online platform gets broken…*
> *Lecturer E: ...we need a good internet connection so there is no disruption during online classes…I don't like to use MS Teams cause it always lags…*

Based on the findings, the inconsistent availability of internet access had a negative impact on the educational experience of students in online classes. The participants in this study faced challenges due to inadequate internet connectivity as it led to decreased attendance, difficulties accessing the learning materials, and disruptions in the teaching and learning process. However, the internet served as a crucial link in the virtual classroom setting. The surge in online activity during the pandemic worsened these issues, as internet connections became strained. Patience, flexibility and alternative approaches, such as asynchronous classes, were adopted to mitigate the impact of unstable internet connections. However, there was a need for better internet infrastructure and support to ensure a smooth and seamless online learning experience for all students and lecturers.

5. Discussion

From the findings, it is challenging to maintain the students' attention in distance learning. There is room for improvement in the current teaching practices to meet the students' expectations and address their shorter attention spans, which are common today. This study found that to cater for inattentive students, lecturers were encouraged to incorporate interactive online platforms, such as virtual manipulatives and gamified activities as they could significantly enhance student engagement and motivation in mathematics distance learning (Akugizibwe & Ahn, 2020). With distance learning becoming increasingly prevalent, students must actively participate to achieve effective learning outcomes. Janni et al. (2022) reported that students who were actively engaged in their learning process and exhibited high levels of motivation tended to perform better and achieve a deeper understanding of mathematical concepts. Moreover, motivated learners were

more inclined to tackle challenging tasks, actively engage with the material, enjoy the learning process, adopt a deep approach to learning, and exhibit improved performance and creativity (Fadzil et al. 2022). Additionally, fostering a sense of community through collaborative projects and encouraging regular communication among students and lecturers was found to positively impact engagement and motivation.

The findings show that there were challenges faced by lecturers in implementing effective communication. It is crucial to create a good learning environment. The lack of communication in mathematics distance learning posed a significant challenge to student engagement and understanding. In line with the finding of the Borba et al. (2016), the absence of face-to-face interaction can hinder the students' ability to seek clarification, ask questions and engage in collaborative problem-solving. Communication in mathematics distance learning can be enhanced by several strategies, including the use of online communication tools (forums, messaging apps), providing clear instructions and guidelines, collaborative assignments, providing feedback, and using multimedia resources like videos (Mahmud et al. 2021). By implementing these strategies, lecturers can promote active student engagement, create opportunities for collaboration and ensure that students feel supported and connected in the distance learning environment.

The integration of effective time management (Santos et al., 2022) with adaptive assessment strategies forms a robust approach to addressing the challenges of mathematics distance learning. This is particularly crucial in online environments where immediate feedback is scarce, a situation that can lead to the entrenchment of misconceptions and hinder the learning process. Without fast feedback, students may continue to practise wrong techniques or fail to grasp mathematical concepts (Hadijah et al., 2022). Adaptive technologies, such as Intelligent Tutoring Systems and online quizzes with automated grading and instant feedback (Almarashdi & Jarrah, 2021), can mitigate this by providing timely responses to student queries and performance. Moreover, this study showed that extra consultation outside the classroom helped students understand mathematical concepts. By implementing these strategies, lecturers can bridge the gap in immediate feedback in mathematics distance learning, facilitating deeper understanding and enhancing student outcomes.

Based on the findings, distance learning in mathematics also faced a lack of physical materials and instruments for demonstrations and visualisations. This made it difficult for online lecturers to teach complex mathematical ideas. Moreover, the asynchronous nature of distance learning often resulted in delays in feedback and clarification that worsened the difficulty in visualising complex concepts. To cater for these problems, lecturers should leverage technology such as Desmos and GeoGebra to provide interactive virtual demonstrations and simulations. Certain software offers dynamic visualisations that enable students to improve their understanding of mathematics theory (Lin, 2022). Furthermore, fostering a collaborative learning environment through discussion forums and group projects can encourage peer-to-peer interaction and visualisation sharing.

By encouraging students to articulate their thought processes and explain visualisations to their peers, they can develop a deeper understanding of mathematical concepts and refine their communication skills.

As shown in the study, the lecturers faced difficulties developing class materials that suited the students' needs. Lecturers need to overcome this difficulty to ensure that mathematics distance learning is successful and not being too prescriptive in teaching methods (Mahmud et al. 2020). Traditional methods of instruction delivered face-to-face provide significant difficulties in attempts to adapt them for use in online environments that aim to increase engagement and understanding. Some findings showed that the older lecturers preferred the traditional method and took longer to prepare the digital class materials relevant to the students. According to Denbel (2023), teaching mathematics through the use of an online platform requires deep planning in the form of psychological testing and the collection of a variety of resources.

Lastly, the findings showed that limited internet connectivity can delay the delivery of mathematics content, slow down real-time communication and restrict access to online resources. As reported by Najib et al. (2017), the most important element affecting the effectiveness of e-learning was the internet connection. To reduce these challenges, lecturers should adopt a blended learning approach that combines offline and online resources. This can include providing downloadable materials, offline textbooks and pre-recorded video lectures, allowing students to access the course content even in the absence of a stable internet connection. Additionally, implementing peer-to-peer learning strategies can significantly raise the students' mathematics achievement (Thurston et al., 2020).

6. Conclusion

This qualitative case study on online mathematics education elucidates the multifaceted challenges that lecturers face, ranging from engaging students to ensuring robust internet connectivity. These hurdles underscore the necessity for a comprehensive framework of support, alongside the adoption of innovative teaching methodologies. The insights gained signal a pressing need for educational reforms, highlighting areas such as the integration of interactive technologies, the enhancement of digital literacy among students, and the professional development of lecturers in navigating the digital learning landscape. This study contributed significantly to the discourse on distance education, advocating for a strategic overhaul to bolster the efficacy of online learning in mathematics and related disciplines.

However, the study's credibility was tempered by its inherent limitations, including a limited participant pool and the potential for researcher bias, despite efforts to mitigate these through member checking. These constraints underscore the importance of extending the research efforts, possibly through mixed-method approaches, to garner a more encompassing understanding of the intricacies involved in online mathematics education. Such expansion is pivotal for deriving insights that are universally applicable and for framing policies and practices that resonate with a broader educational context.

Looking ahead, future research endeavours should aim to fortify student engagement, refine communication channels, enhance immediate feedback mechanisms, overcome visualisation barriers and tackle internet connectivity issues. Delving into the effectiveness of digital tools for concept demonstration and material engagement, alongside exploring strategies to mitigate internet accessibility challenges, could pave the way for significant improvements in distance learning outcomes. The adaptation and evolution of online learning environments, informed by the findings of such studies, are crucial for optimising educational practices and achieving superior student performance in mathematics and beyond.

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