Research Article

Digitalization of Mathematics Teaching in Hybrid Mode

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ABSTRACT

Global changes have changed our educational system from a pandemic to a new normal. Teachers have adopted new learning delivery to cope with the demands of this era. This change has shifted classroom set-up into online classes, requiring teachers to digitize the education process. With this, different issues of coping mechanisms were explored to make learning possible. This study aimed to explore (1) the perceptions of participants in digitizing math teaching, (2) challenges met in digitalization, and (3) the coping mechanisms to address the issues encountered. It made use of the Narrative research design and employed purposive sampling in choosing its participants. Three semi-structured open ended questionnaire were used in gathering data. Results showed that participants viewed teaching math online as difficult and at the same time engaging. The difficulties faced were seen in students' focus on the discussion, lack of gadgets, computation skills, and digital competency. Various coping mechanism were suggested to cope with the difficulties like; utilizing online application, providing helpful activities and having positive attitudes towards the issue. In conclusion, it is found that teaching math online is difficult as compared to face-to-face classes, hence it is recommended that training on the digital competency and technology must be prioritized to further cope up when teaching math online.

Keywords: Digitalization, Digital competency, Digital technology

Introduction

A study on the "Effectiveness of the Flipped Classroom in the Teaching of Mathematics in an Online Environment", found generally favorable student perceptions of the flipped classroom methodology and virtual sessions. However, it noted slightly negative perceptions regarding virtual sessions, influenced by the frequency of digital resource use and electronic devices. Beckman (2024), explored high school math teachers' views on online teaching and learning, providing insights into their experiences during the rapid shift to online education due to the COVID-19 pandemic. Research on mathematics teachers' perceptions of internet use for online mathematics learning indicates that it is generally seen as an additional and complementary resource. Nevertheless, the study also points out limitations in online math learning due to restricted interaction and

material delivery. A systematic review by Saat et al., (2024) highlighted that digital tools can improve students' learning outcomes, problem-solving skills, engagement, and exploration in mathematics education.

According to Alsaaty et al., research and discussion on the relative merits of different learning modality in higher education have been a topic of interest. While some says that traditional face-to-face is still more successful than online learning, others contend that online learning is far superior, and yet others indicate that a blended or hybrid approach would be the most efficient way to educate to students. For years, face-to-face instruction has been the ideal way of teaching. It gives students opportunity to be engage with their teachers and other students directly, foster active participation, and promotes the sense of community belongingness in the classroom. However, the advantage and drawbacks of the traditional instruction have been topic of concern with the emergence of online learning and the integration of technology in teaching. The chance for greater learning and teacher connection is one of the main benefits of in-person instruction. Through direct interaction with the course material, question-asking, and real-time feedback, students may improve their comprehension and familiarity of the information. Furthermore, face-to-face instruction promotes collaborative learning more effectively as it allows students to work together on group projects and debates, which builds engagement and a feeling of community (Kemp & Grieve, On the other side, there are some drawbacks to face-to-face instruction as well. Since they might not be as nervous around their friends and teachers, some students could feel more at ease speaking their opinions in an online setting (Eppendi et al.. Furthermore, because students may take classes from the convenience of their homes rather than having to go to a physical site, online courses can provide greater flexibility and practicality.

Additionally, the COVID-19 pandemic has brought attention to a few potential drawbacks of in-person instruction. Students have reported feeling more stressed and having physical and mental health issues as a result of the

disruptions caused by the pandemic. In addition, in-person instruction may be more susceptible to interruptions and distractions, such as arguments with family members or challenges managing noise (Quesada et al. Additionally, the COVID-19 pandemic's shift to online instruction has brought attention to the value of flexibility and teachers' capacity to meaningfully modify the dynamics of their classes as needed. Despite these potential drawbacks, many students still prefer the face-to-face learning environment, as it can provide a more immersive and engaging learning experience. As educational institutions continue to explore the balance between online and face-to-face learning, it is important to consider the unique needs and preferences of individual students, as well as the specific learning objectives and course content. Many students still favor in-person instruction over virtual learning environments in spite of these possible disadvantages since it can offer a more immersive and interesting learning experience. While academic institutions continue to investigate how best to mix in-person and virtual learning, it is critical to take into account each student's particular requirements and preferences in addition to the course material and learning objectives.

Online learning has become increasingly popular in today's quickly changing educational environment, bringing with it both possibilities and problems for educators and students. One of the main benefits of online classes is the flexibility they provide. The COVID-19 epidemic has further expedited the adoption of remote learning, establishing its status as an essential part of the "new normal" and the "next normal" in education. With the ability to access course materials and engage in classroom activities from home, students may accommodate a variety of schedules and commitments and do not need to commute (Thi [11]). (Xie et al. . Furthermore, online education gives students the chance to acquire critical digital competences, which are becoming more and more important in the quickly changing labor market (Kulikowski et al.. Some disadvantages of online learning do exist, though [13]. Unreliable internet connections and restricted access

to required equipment are examples of technological limitations that can impede the learning process (Taghap as well as lower student motivation due to the lack of in-person interactions and a sense of community. One of the biggest challenges in an online learning environment is keeping your attention and avoiding distractions. Online learning has a number of drawbacks, including lower student engagement, technological obstacles, difficulty recalling material, and issues focusing. However, it also allows for greater flexibility and the development of digital skills. The best way to meet the varied requirements of students and guarantee their academic achievement as the educational landscape changes further may be to adopt a balanced strategy that combines the best elements of traditional and online learning environments.

According to Crews and Butterfield recent research has brought attention to the complexity of this argument by indicating that the best learning mode may vary depending on the particular subject matter, the characteristics of the students, and the combination of online and in-person learning. One study, for example, discovered that although students favored in-person training, they reacted favourably to a "flipped classroom" strategy that blended online and in-person components. According to another study, opinions of traditional face-to-face instruction vs online learning may differ among students, especially those from minority student groups.

Recent studies have highlighted the nuanced nature of this debate, suggesting that the optimal learning modality may depend on the specific subject area, student characteristics, and the integration of online and in-person components. For instance, one study found that while students generally preferred face-to-face instruction, they responded positively to a "flipped classroom" approach that combined online and in-person elements [9]. Similarly, another study suggests that students' perceptions of online versus traditional face-to-face learning may vary, particularly among minority student population. It's interesting to note that the majority of research to date has concentrated on fully online or fully face-to-face courses, with little investigation into the

emerging trend of "blended e-learning," in which online components are added to traditional in-class activities rather than taking their place. Given that the combination of online and in-person components may have a substantial impact on student engagement, performance, and attrition, this constitutes a substantial vacuum in the research. Future studies should examine student preferences and experiences with a variety of learning modes, such as in-person, online, and blended learning, to close this gap. Educators may better fulfil the different requirements of students in the digital era by optimizing learning settings via a more nuanced knowledge of the advantages and disadvantages of each strategy.

Interestingly, the existing research has primarily focused on courses offered entirely online or entirely face-to-face, with limited exploration of the growing trend towards "blended e-learning" where traditional in-class activities are supplemented, rather than replaced, by online components. This represents a significant gap in the literature, as the integration of online and in-person elements may have important implications for student engagement, performance, and attrition .To address this gap, future research should delve deeper into student preferences and experiences across the spectrum of learning modalities, including face-to-face, online, and blended approaches. By gaining a more nuanced understanding of the strengths and limitations of each approach, educators can optimize learning environments to better meet the diverse needs of students in the digital age.

Globalization has brought changes in our educational system. This includes acquiring 21st century skills that could adopt to the demand of the global market as well as to the various global activities. Digitalization is required to cope up with the demand of this era.

Another significant in our history was the digital revolution in teaching as brought about by the pandemic. The pandemic prompted a global crisis in education that led to unprecedented school closures and national lockdowns. This experience has led teachers to embrace the challenges in shifting to online classes and Math teaching is not an exemption. The

digitalization became a prominent factor of inequality in education worldwide, with certain issues of internet connectivity and the validity and reliability of assessment process. Despite of the limitations, majority of the teachers considered the pandemic as an opportunity for growth of becoming a better and digitized teacher.

The post-pandemic era has brought significant shift in the landscape of education, particularly in the realm of digitalization of teaching. The use of technology and digital tools have brought significant impact in the practices observed in educational set-up. Hybrid Learning Models were introduced. Digital literacy was enhanced. Innovative teaching strategies and professional development were given emphasized.

Digitalization has transformed the landscape of math education, offering innovative and interactive ways to teach mathematics in an online mode. Through the integration of digital tools, platforms, and resources, educators can create dynamic and engaging learning experiences that cater to diverse learning styles and abilities. One of the key advantages of digitalization in math education is the ability to provide personalized learning experiences. Online platforms can offer adaptive learning pathways tailored to individual student needs, allowing learners to progress at their own pace and receive targeted support where necessary. This personalized approach enhances student engagement and comprehension, leading to improved learning outcomes. Furthermore, digital tools such as interactive simulations, virtual manipulatives, and educational games enable students to visualize abstract mathematical concepts and engage in hands-on learning experiences. These tools make math more accessible and relatable, fostering a deeper understanding of mathematical principles through experiential learning.

Additionally, the collaborative nature of online learning environments facilitates peer-to-peer interaction and group collaboration, enabling students to engage in discussions, problem-solving activities, and virtual teamwork. This collaborative approach not only enhances students' mathematical communication and reasoning skills but also promotes a sense of community and shared learning among peers. Moreover, digitalization allows for real-time feedback and assessment, enabling educators to monitor student progress, identify areas of difficulty, and provide timely intervention and support. By leveraging data analytics and learning analytics tools, teachers can gain valuable insights into student performance and tailor instruction to meet individual learning needs effectively. In conclusion, digitalization is a powerful means to teach math online, offering a wealth of opportunities to enhance learning, promote interactivity, and foster a deeper understanding of mathematical concepts. By harnessing the potential of digital tools and technologies, educators can create dynamic and engaging math learning experiences that empower students to develop critical thinking skills, problem-solving abilities, and a lifelong appreciation for mathematics.

As teachers of the 21st century, one should be abreast with navigation of new technologies and social media, manages different sources of information, combine basic knowledge that complete online tasks and developed online skills. Having shifted to new normal, institutions tend to adopt to the hybrid delivery mode of learning. Teachers as well as students need to acquire technology skills that complies with the demand of digital world. Digital competence is required to be confident in the critical usage of the full range of digital technologies of information, communication and basic problem-solving in all aspects of life.

McGarr &Mc Donagh stated that the pervasive use of digital technologies in all areas of life calls for the need for new skills and competencies. Referring to this need, Ala-Mutka noted that 'there are different digital competence should be acquired at school. Ilomki et al., mentioned that as a result, it has received a lot of attention in the field of worldwide educational research., and García- Martín and García-Sánchez stated that where a sizable body of research has been conducted in the field of digital competency in education, notably in teacher education. Brox discovered that during the past ten years, a lot of work has gone into identifying the precise requirements for new teachers' digital skills and how their training should be enhanced (p. 130). This attention extends to

underdeveloped countries as well as industrialized ones that have a history of adopting ICT for education.

According to Ghomi & Redecker, every citizen must acquire digital competence in today's world of technology and the internet. This is because digital competence is a crucial lifelong learning skill that promotes social inclusion, employability, personal growth, and active citizenship (Council of the European Union, 2018). This does not absolve educators from obtaining these competencies, which will further improve instruction in this digital age. The term "digital competency" is a "moving target in the sense that it evolves rapidly and in line with the appearances of new technologies," according to Tomte, as referenced by McGarr & McDonagh (p.140). Digital competencies are described as the "integrated and functional use of digital knowledge, skills, and attitudes" as stated by Aesaert et al.

In the modern world, digitizing is essential because it helps us succeed in an increasingly digital environment by enabling us to manage and take use of technologies. It fosters the critical and assured use of electronic media for communication, business, and play. In the new normal, this competency becomes necessary for teachers.

The goal of digitizing education, according to Djidu & Retnawati , is to change education by using digital platforms—both online and offline—as a means of delivering services to the educational sector. Digitization involves more than just transferring data and carrying out operations and calculations utilizing digital technologies. The two facets of digitalization are the merging of the physical and virtual worlds and the relationship between people and things.

Schmidt & Tang assert that digitization is changing society, not just workplaces, and that this change is taking place in educational contexts with or without deliberate efforts to maintain the caliber of the learning and teaching environments. While the use of technology into education is not new, the speed and rate at which it is developing is, particularly regarding new Internet, ICT, and digital technologies.

Following the pandemic, most schools adopted a mixed approach to education. Because digital competency is a skill used in blended learning online programs, all teachers should acquire it. Bryan [20] asserts that implementing digitalization in the classroom can introduce pupils to new methods of instruction. Additionally, he pointed out that integrating digitization into extracurricular activities can enhance retention in a continuous learning process. According to Murugesan , a teacher's function in the twenty-first century will shift from imparting knowledge to one of learning facilitator, collaborator, guide, couch, and mentor.

After the pandemic, the Commission on Higher Education released a memorandum on the returning of face-to-face classes form online classes. This includes guidelines and protocols to follow. It also addressed the importance of monitoring the situation closely in response to adapt to any changes in the pandemic status. Additionally, it reminded the school observe collaboration among stakeholders that highlighted as essential for successful transition. Despite of this order, other institution still observed online classes due to lack of classrooms.

In a hybrid learning environment, teachers' responsibility for digitization becomes mandatory. This is not limited to teaching alone; in addition to being able to utilize technology in online forums and to submit reports, upload data, modify, and create learning materials, they should also possess strong technological skills. Teachers who are not proficient in using technology are hampered by these digital activities. The output of student learning and the turnaround time for reporting in the workplace are both impacted by teachers' lack of proficiency with digitalization. One of the causes of this incompetence is resistance to change; teachers are ill-prepared when it comes to using technology, which frequently results in student failure.

Blackboards have historically been the chosen teaching tool for math teachers when discussing visual computation in a lesson. Blackboards can be used by both teachers and students to practice addressing problems that call for solutions. Both in-person and virtual classes are used in this hybrid approach. One of the issues math teachers run into while teaching online is the part where they have to use the

visual blackboards for problem solving. This issue is noted and, despite the availability of virtual whiteboards, is not well practiced in an online environment; math teachers encounter this as well as other issues in a hybrid approach. Researchers wish to get the perception of math teachers towards this issue and what are the challenges and coping mechanisms math teachers employ to deliver learning to students.

Objectives:

The general objective of this study is to present Math teachers' Perception on digitalization of Mathematics Teaching in Hybrid Mode. Specifically, it aimed to answer the following:

1. What is the participant's perception of digitizing math teaching?
2. What challenges are met by the participants in digitalization of Math teaching?
3. What coping mechanisms are made to address these challenges?

Methods
Research Design

The Narrative Research Design was used for the Current Study. According to Creswell and Plano, narrative research is an approach to inquiry in which the researcher examines people's lives and requests accounts from one or more of those people. Narrative Research Design was used in the study to understand Math teachers' Perception on digitalization of Mathematics Teaching in Hybrid Mode. Thematic Analysis was used to analysis data. According to Braun and Clarke [23], Thematic Analysis is used to analyze qualitative data to answer research inquiries about people's perception

Participants of the Study

The present study employed purposive sampling technique to identify the participants of the study. Purposive sampling is a non-probability sampling whereas participants are chosen based on the objectives of the study. In the present study, participants will be selected on the following criteria: a.) must be a Mathematics Teacher in an institution, b.) have been integrating technology in teaching for 2 or more years, c.) have had experience with online classes.

Instrument

The present study utilized 3 semi-structured open-ended questionnaire. The semi-structured questionnaire includes open-ended questions, too, so that qualitative information can be gathered. The first question pertains to the participant's perception of digitizing math teaching. The second question concerns the challenges the participants met in the digitalization of Math teaching. Lastly, the participants' coping mechanisms for addressing the said challenges were discussed.

Data Gathering and Analysis

To administer the research instrument and carry out the study, authorization was obtained from the corresponding Heads of the Agency. The researcher administered the questionnaire through Google Forms to the study participants after explaining the study and receiving consent. Following the collection of data, the data was analyzed in the strictest confidence using the theme analysis. Thematic Analysis was used to analyze data. According to Braun and Clarke, Thematic Analysis is used to analyze qualitative data to answer research inquiries about people's perceptions. The present study utilized the five (5) steps of thematic analysis to understand Math teachers' Perceptions of the digitalization of Mathematics Teaching in Hybrid Mode, which includes data familiarization, generating codes and themes, reviewing, defining and naming themes, and locating exemplars.

Ethical Consideration

The study was conducted with the utmost consideration for all ethical procedures. This includes obtaining permission to administer the study from the heads of the various departments, asking respondents and participants if they wish to participate, and informing them of the purpose of the study. Finally, the researchers will guarantee that the information gathered will be handled in the strictest confidence and used exclusively for the purposes stated above.

Results and Discussion

Math digitalization instruction offers flexibility and convenience, allowing students to learn at their own pace and in a personalized manner. However, several issues can hinder the effectiveness of online math instruction, including challenges related to the lack of access to gadgets, student focus, digital literacy, and teacher competency. The following are participants 'responses that yielded themes based on the thematic analysis.

Participants' Perception of Teaching Math Online
Difficult Subject to Teach

Teaching Math online presents challenges that make it more difficult compared to traditional face-to-face instruction. The attention span of students in an online set-up is too short, for distractions are one click away. Moreover, the nature of different Math concepts requires hands-one experience for students to understand. Furthermore, the validity of the assessment results may somehow make it more difficult for the instructors to assess their students. The following were responses in verbatim...

"There are times that it is difficult to assess the real class standing of the students. For other students use dual gadgets, one for copying their classmates' answers on GCs". - P1

"For me, slight difficulty because of some unnecessary distraction during online class" _P3

"Teaching mathematics online has posed many difficulties at the onset of the hybrid learning mode. The primary challenge is how to effectively invite the attention and interest of the students online. There are so many factors that have inhibited the goals of mathematics education online, one of which is how to best replicate the conventional board-work type of formative assessment, which I think is one of the most effective ways to teach mathematics." – P6.

"Mathematics is one of the challenging subjects taught to the students, and it becomes more complicated in an online setup."- P9.

Engaging Subject

Mathematics, often perceived as a challenging and abstract subject, possesses unique qualities that can make it engaging and captivating for learners. The following responses contribute to the appeal and fascination of math:

"As a Math Teacher, digitizing math teaching can make learning mathematical concepts more accessible to students. Virtual classrooms may allow students and teachers to engage themselves in various learning styles and platforms. Digital tools will enable students to experience interactive learning in terms of visualization of graphs and equations. Furthermore, collaborative problem-solving activities between students and teachers through virtual classrooms can increase motivation and support for overall learning experiences. It also offers flexibility to where and when students can learn, which is beneficial for blended learning.

Teaching maths in an online setting is just like how they teach during f2f sessions, but in analogy, it is more like: Students are watching YouTube tutorials about the topic but making it more interactive."- P6.

Math instructors utilizing digitalization responded with two contradicting perceptions: Math is viewed as a complex subject, for they had trouble assessing students on quizzes and even other activities. Distractions are also present, which add to the difficulty of getting the attention and focus of the students. At times cheating is observed for students who used dual gadgets to access possibilities of getting answers. In Pulungan [24], studies showed that students had difficulties understanding math materials and completing tasks given by the teacher. Likewise, teachers also experienced difficulty in assessing learning objectively and transparently.

Difficulties Faced in the Digitalization of Math Instruction

Digitalization of mathematics instruction has the potential to transform the learning experience, making it more interactive, engaging, and effective. However, several challenges must be addressed to fully realize its potential. The sudden shift from math instruction to digitalization resulted in difficulties for math instructors. The responses yielded sub-themes. The following are responses in verbatim...

Students Focus on the Discussion

"Most of the time, students do not respond during discussions and after the class at a time after work."-P2

"Students cannot focus entirely like in face-to-face class because of its online class." - P5

"Students lack focus and start tinkering with their phones or their laptops while listening to their instructors."- P6

"Some students prefer f2f sessions; the traditional board-and-marker because it is more interactive not only with their instructors but also with their classmates."- P1.

"Students are not interested in the subject itself, and it is hard to motivate them during online setup." – P3.

Lack of Gadgets

"Digitalization of mathematics instruction may be a bit difficult for those who do not have the appropriate equipment and resources as well as those who are lacking in training and experience in using digital platforms in teaching the subject." – P7.

"There are different challenges involved in the digitalization of math instruction, one of which is that not all students have access to the use of gadgets and internet which can create differences in learning experiences and outcomes." – P9.

Computation Skills

"Students difficulties on computations or problem-solving process."- P10

"Some students prefer f2f sessions; the traditional board-and-marker because it is more interactive not only with their instructors but also to their classmates." – P11.

Digital Competency

*"*Both teachers and students need to enhance their digital literacy skills to navigate the digital learning tools effectively"- P3.

"Making a presentation in math is very time-consuming and requires a lot of patience, time and effort."- P4.

The difficulties faced by Math instructors in the digitalization of Math results are the students' focus on the discussion, lack of gadgets, students' computation skills, preferences, and digital literacy. These difficulties faced by math instructors in digitalizing math instruction can have various effects on their teaching practices, student engagement, and effectiveness. As stated in the study of Nailufar et al. [25], teachers experienced difficulties in online learning, namely learning planning in determining learning methods, making learning media, and determining three types of affective, cognitive, and psychomotor assessments. Difficulties in implementing learning in preliminary activities are preparing students psychologically and physically and providing motivation; core activities are observing, asking questions, digging and collecting information, and communicating and closing activities on feedback, follow-up, and information on further activities. The difficulty of providing an assessment in applying three types of affective assessment: observation, self-assessment, and assessment between students and journals. Cognitive on written tests, oral tests, and assignments and psychomotor on practice, projects, and portfolios during online learning in Mathematics.

Coping Mechanism to Address the Challenge

Coping mechanisms are essential in addressing the challenges of digitalizing math teaching as they foster resilience, reduce stress, enhance problem-solving skills, promote continuous professional growth, and facilitate the building of supportive networks. By employing

effective coping strategies, math instructors can navigate the digital realm with confidence, adaptability, and a positive mindset, ultimately improving their students' quality of math education. Responses showed themes based on analysis.

Utilizing Online Application

"I watched and implemented tutorial videos to enhance my digital literacy in order to cope and familiarize the proper way of using the different digital learning platforms."-P4.

"I strategies on providing a tool during discussion or computation process"-P7

Providing Helpful Activities

"One of the coping mechanisms I used is by providing asynchronous activities to those students who are having difficulties with the usage of their gadgets and internet." – P10.

"Recitations. Sudden recitations during the online sessions to keep their attention and to make it more interactive and engaging"- P6

Positive Attitude towards Challenges

"Providing a fair extension and considerations to submissions and deadlines are adequate to comply with their activities." – P5.

"I allot more time preparing my materials that are catchy to the attention of the students, and I make the lesson look easier. I gave more examples and drills for them to understand the lesson." = P7

The themes resulting from the coping mechanisms employed by math instructors are utilizing online applications, providing helpful activities, and fostering positive attitudes toward challenges. Effective coping mechanisms contribute to professional growth for math instructors. Furthermore, coping mechanisms foster critical thinking, creativity, and resourcefulness, enabling instructors to identify alternative solutions to difficulties encountered. In the study of Talahiban et al. [26], the

authors agreed, based on their studies, that they adopted coping strategies or mechanisms that helped them overcome the challenges and difficulties of the new regular education, allowing them to adjust and fit into the new educational environment.

Conclusion and Recommendation

Based on the result, the researcher concludes that math teachers perceive mathematics as a complex subject to teach during online classes compared to traditional face-to-face classes. And with the use of appropriate technology, it can be engaging for students. Further, some of the challenges encountered by math teachers during online classes include student's lack of focus, lack of gadgets, and poor computational and digital skills. To cope with these challenges, math teachers utilize online applications to catch students' attention and provide helpful activities such as asynchronous sessions to address students' lack of gadgets and reinforce them with a positive attitude.

Indeed, traditional face-to-face learning is far easier for Math teachers compared to the Online set-up; however, with the emergence of the digital era, Mathematics teachers need to step up and embrace these changes. Hence, the researcher recommends that activities training about the use of digital technology should be given to math teachers not only to enhance their digital competency but also to expand their teaching options on how to maximize digital technology in teaching mathematics. In addition, studies pertaining to the level of Math teacher's digital competency are recommended as a basis for activities and training.

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