Analysis of the Implementation of Remote Learning Platforms in the Context of Mathematics Education During the Pandemic

Nurhaya[1], Ahmad Nasrullah[2*], Ade Evi Fatimah[3]
[1,2]Mathematics Education, Universitas Islam Negeri Mataram, Indonesia.
[3]Primary Teacher Education, Sekolah Tinggi Keguruan dan Ilmu Pendidikan Al Maksum, Indonesia.
210103050.mhs@uinmataram.ac.id[1], ahmadnasrullah@uinmataram.ac.id[2], eviade997@gmail.com[3]

Abstract: This study constitutes a Systematic Literature Review aimed at analyzing the utilization of distance learning platforms in the context of mathematics education during the pandemic period, drawing literature from indices such as Scispace, Elicit, and data retrieved from Google Scholar spanning the years 2013 to 2023. The research findings pinpoint several significant challenges encountered by educators, students, and parents in the implementation of remote learning. Primary obstacles include technical difficulties, low student motivation, and environmental support limitations. Nevertheless, potential for improvement is identified through teacher training, platform optimization, reinforcement of educators' roles, and infrastructure investment. Knowledge gaps emerge involving students' fundamental understanding, connectivity challenges, as well as teacher readiness and training. This study provides in-depth insights into the dynamics of mathematics education during the pandemic era, with implications for the development of more effective educational policies and strategies.

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A. INTRODUCTION

Distance learning is an instructional approach that facilitates interaction between learners and educators without the need for physical presence in the same location (Novayanto et al., 2023). In this context, the learning process takes place through various digital platforms and communication technologies, enabling access to education from a remote location. Learners can participate in classes, access learning materials, and communicate with educators through various electronic media (Alfi & Febriasari, 2023). With the advancement of technology, distance learning has become a crucial solution in sustaining the continuity of the education process, particularly in situations like the global pandemic, where physical presence in educational institutions is limited (Alfi & Febriasari, 2023). This approach not only overcomes geographical barriers but also provides flexibility for learners to manage their study time according to their individual needs. Thus, distance learning is not merely an alternative but a necessity in responding to the dynamic changes in contemporary education systems (Learning, 2015).

The significance of distance learning platforms as a primary solution to continue the educational process during the global pandemic has become a fundamental aspect in

addressing the challenges faced by the education sector (Novayanto et al., 2023). The pandemic, with all its limitations and risks, has altered the paradigm of traditional education. In this context, distance learning platforms emerge as a crucial response to sustain the educational process without compromising safety and health (Ali Saukah, 2021). Through these platforms, educational institutions can conduct virtual teaching and learning activities, facilitating interaction between learners and educators without physical presence in the same location. The existence of distance learning platforms not only overcomes geographical constraints but also provides flexibility in scheduling study sessions, accommodating the individual needs of learners (Permana, 2021). Therefore, in facing the global pandemic, distance learning platforms serve as a strategic foundation that not only maintains the continuity of education but also opens the door to a new paradigm in a more adaptive and responsive learning approach to environmental changes (Muhammad Ihsan, 2024).

Teaching mathematics through remote learning platforms faces specific challenges that need to be addressed to ensure its effectiveness. One of the primary challenges is the complexity of the content inherent in mathematics education (Umar et al., 2020). This subject often involves abstract and intricate concepts, requiring profound understanding and active interaction between educators and learners (Lumuan et al., 2023). In the context of remote learning, the transfer of understanding mathematical concepts can become more intricate without direct guidance, given the limitations in physically demonstrating processes and steps (Nurdyansyah, 2016). Additionally, challenges related to interpersonal interaction are also a serious concern. Direct interaction between learners and educators plays a crucial role in facilitating the understanding of mathematical concepts. With remote learning platforms, this aspect may be diminished, complicating the processes of discussion, question-and-answer sessions, and direct responses, which can impact learners' comprehension levels (Nurdyansyah, 2016). Therefore, addressing these challenges requires innovation in the design of mathematics education that enhances the depth of understanding and facilitates interpersonal interaction through remote platforms (Hamidah, 2023).

The global pandemic has necessitated a shift to remote learning, posing numerous challenges in the context of mathematics education. Limitations inherent in virtual platforms hinder the effectiveness of conveying and transferring mathematical concepts, often requiring profound understanding and direct interaction (Klemer & Segal, 2023). The inability to engage in interpersonal interactions between educators and students further complicates the teaching and learning processes in mathematics (Popławska, 2023). Therefore, adjustments in mathematics teaching methods become crucial to ensure effective learning, both during the pandemic and in the future (Cruz & Hernandez, 2023). These adjustments should focus on educator engagement and promoting a profound understanding of mathematical concepts under various learning conditions (Salimaco et al., 2023). Policymakers are also advised to consider providing adequate knowledge and technical support to assist teachers in successfully integrating computerized technology into their teaching processes (Arpilleda et al., 2023).

Previous research has underscored the benefits of various web applications and platforms in distance learning during the pandemic. Teguh & Suyatna (2021) highlighted the use of web

applications as a solution for remote learning, while Handayani, et al. (2022) focused on the training of the Rumah Belajar portal for mathematics and science teachers. Siregar, et al., (2021)discussed the utilization of various online learning applications to inspire creativity in teaching, and Yuniar (2016) emphasized a problem-based learning approach to enhance mathematical problem-solving skills. Collectively, these studies affirm the potential of web applications and platforms in enhancing the quality of distance learning in mathematics during the pandemic.

There exists a knowledge gap in the literature regarding the utilization of distance learning platforms in the context of mathematics education during the pandemic era. Savosko & Komarova (2021) underscore the joint use of virtual and physical manipulatives to enhance mathematical skills. However, research by Shafipour, et al. (2017) notes that online mathematics learning exhibits lower completion rates compared to classical classroom learning. There is evident interest from both teachers and students in learning through technological platforms, yet there remains a deficiency in mastery in using these tools. Therefore, further research is warranted to address this gap and explore the potential of distance learning platforms in mathematics education during the pandemic era.

This research focuses on identifying effective adjustment strategies in teaching mathematics through virtual platforms. It also necessitates exploration into methods for enhancing teachers' proficiency with technological tools and providing policy recommendations to support successful implementation. Thus, the research can serve as a guide for the development of practical solutions and policies that facilitate effective mathematics learning in remote learning situations, particularly during the pandemic and in the future.

B. METHOD

The primary objective of this research is to thoroughly investigate the use of distance learning platforms in mathematics education during the pandemic. The research focus encompasses understanding the successes, challenges, and critical aspects in the integration of such technology. The study also aims to identify the role of educators, student interaction, and policy impacts on the effectiveness of mathematics learning in the context of distance education. Literature search was conducted through prominent scholarly databases such as Scispace, Elicit, and Google Scholar. Keywords employed encompassed terms such as "mathematics education," "distance learning," "pandemic period," "challenges of distance learning," and "teacher training." The literature review spanned the period from 2013 to 2023 to ensure the inclusion of relevant data pertaining to the pandemic era.

Inclusion criteria encompass articles specifically addressing the utilization of distance learning platforms in mathematics education during the pandemic. Articles featuring qualitative research methods, empirical findings, and relevant analyses will be incorporated. Exclusion criteria involve reviews lacking empirical data, non-academic articles, and those not directly related to the use of learning platforms in the context of mathematics during the pandemic. Article selection was conducted using a Systematic Literature Review approach involving two or more independent researchers. Articles meeting the inclusion criteria were

chosen, and relevant data were extracted. The extracted data included research methods, findings, and analyses related to the use of distance learning platforms in mathematics education. Inter-researcher discussions were conducted to ensure consistency and the validity of data extraction. Through this research methodology, it is anticipated that a profound understanding of the role of distance learning platforms in the context of mathematics education during the pandemic can be attained. Additionally, it is expected to identify gaps and provide valuable insights for the development of mathematics learning strategies during the pandemic and in the future.

C. RESULTS AND DISCUSSION

1. Implementation of Distance Learning Platforms in the Context of Mathematics Education During the Pandemic.

The implementation of distance learning platforms for mathematics during the pandemic has encountered various obstacles and challenges. Educators face difficulties in delivering practical applications and encounter constraints at both the teacher and student levels (Rahmatia, 2023). Students confront learning difficulties, including deficiencies in basic knowledge, low interest and motivation, challenges in comprehending materials, and a lack of support from the learning environment and parents (Arpilleda, et al., 2023). Parents also express concerns regarding their children's understanding of mathematical concepts, incomplete explanations from teachers, internet disruptions, and limitations in optimal learning (Murtiyasa, et al., 2023). Moreover, the abrupt shift to online learning has resulted in a decline in student engagement, attributed to internet instability, monotonous learning experiences, challenges in self-directed learning, and a lack of confidence due to limited interaction with classmates (Muhamad Galang Isnawan, Azis, 2023). To address these challenges, it is recommended to provide additional training and support for both teachers and students, develop detailed explanations, and leverage integrated learning approaches (Rada, et al., 2023).

The utilization of distance learning platforms in the context of mathematics education presents several challenges. According to Fredlina, et al. (2020), there is an emphasis on the need for an engaging and enjoyable mathematics learning experience, with the suggestion that technology can contribute to creating such an experience. Sunendar (2017) highlights the significance of problem-solving skills in mathematics education, which is often challenging to develop in a distance learning environment. Although Ferryka (2017) proposes the use of games such as "snakes and ladders" to enhance joy in mathematics learning, the feasibility of its application in distance learning remains a question. Mamat, et al. (2022) underscore the difficulties in mastering basic mathematical concepts, particularly in rural areas, emphasizing the need for varied teaching approaches. Overall, these studies indicate that while technology can enhance mathematics learning, its use needs to be adapted to the specific challenges of distance learning, such as maintaining student engagement and ensuring access to resources.

From this research, it can be interpreted that the implementation of distance learning platforms for mathematics faces serious challenges across all levels of education. Teachers, students, and parents each encounter unique obstacles in the learning process. These difficulties encompass technical, motivational, and environmental support aspects. This

highlights the need for holistic and sustainable solutions to enhance the effectiveness of online mathematics learning. Evaluation of the research findings indicates that the use of distance learning platforms in mathematics education has significant impacts, both positive and negative. Technical constraints, low motivation, and lack of support require special attention in distance learning planning. Additionally, accessibility inequalities in rural areas pose a serious issue that demands policy attention.

2. **Student Participation and Engagement in Distance Learning in Mathematics Education**

Student participation and engagement in distance learning, along with achievement through the use of distance learning platforms in mathematics, exhibit variations in various studies. Sukiyanto found that students demonstrate high motivation in online mathematics learning, with the highest scores on indicators of enthusiasm (Anggreini, et al., 2022). Panjaitan and colleagues highlight that students' perceptions of online learning are still lacking, particularly concerning the readiness of instructors and students' confidence in their competence after participating in the learning process (Panjaitan, et al., 2023). Hamdi emphasizes that distance learning enables a sustainable education process with a high level of safety and is positively responded to by students (Novitska, 2023). Murtiyasa identifies internal and external factors contributing to students' difficulties in learning mathematics during distance learning, including a lack of interest, motivation, and challenges in understanding the material (Murtiyasa et al., 2023). Studies on the transactional aspects of distance learning find that the mathematics performance of students in the online modality is higher compared to those in the modular modality (Mendoza & Juacalla, 2022).

Student involvement and participation in distance learning, as well as the achievements obtained through the utilization of distance learning platforms in mathematics education, constitute a highly significant research focus (Sunendar, 2017). These factors become crucial in enhancing students' abilities in mathematical problem-solving, often perceived as inadequate (Neneng Nur, 2023). To address these challenges, innovative and enjoyable models of mathematics learning, such as game-based learning, have been proposed. Additionally, the integration of problem-solving in the context of mathematics education is considered a key strategy to enhance students' problem-solving skills (Sunendar, 2017).

Variations in research outcomes indicate that despite some students being highly motivated and engaged in online mathematics learning, there are still challenges that need to be addressed, particularly related to student perceptions and internal factors. The success of distance learning in mathematics also depends on how students respond to it. Evaluation of research findings suggests that the level of student participation and engagement tends to vary, with some students demonstrating high motivation, while others face difficulties and challenges in understanding the material.Student perceptions of instructor readiness and confidence in their competence emerge as aspects that require further consideration.

3. Challenges and Successes Encountered by Educators in Utilizing Distance Learning Platforms in Mathematics Education.

Educators utilizing distance learning platforms to teach mathematics face various challenges and achievements. These challenges encompass difficulties related to social aspects, accessibility of online resources, course nature, online learning skills, and instructional constraints (Denbel, 2023). Teachers also encounter barriers in implementing online learning, particularly at the teacher and student levels (Arpilleda et al., 2023). During the COVID-19 pandemic, mathematics educators faced challenges in implementing printed distance modular learning, such as incomplete modules, copied answers, and the volume of modules to be checked (Arzaga, 2023). College instructors teaching mathematics online feel challenged in developing engaging content and providing feedback (Bontogon, 2022). Nevertheless, there are also successes in using distance learning platforms. Distance mathematics learning devices employing the PQ4R learning strategy have proven to be valid, practical, and effective, eliciting positive responses from students and achieving good learning outcomes (Sadieda et al., 2022).

The utilization of cooperative learning models, such as Student Teams Achievement Division (STAD) and Numbered Head Together (NHT), has proven to significantly enhance learning outcomes across various subjects (Neneng Nur, 2023). These models promote active participation and collaboration among students, which is particularly crucial in remote learning situations. However, the success of implementing these models is also linked to effective proficiency in using digital platforms, posing a challenge for educators (Srikartika et al., 2019). Therefore, it becomes essential for educators to receive adequate training and support in leveraging these platforms to enhance the effectiveness of cooperative learning models in distance learning.

Educators face challenges across various aspects, ranging from social factors to technical issues. Social aspects encompass student interaction and engagement in learning, while technical constraints include proficiency in using technology and accessibility to online resources. Instructional challenges arise in the implementation of printed distance modular learning. On the other hand, success seems to stem from the use of distance mathematics learning devices employing the PQ4R learning strategy. This tool is evaluated as valid, practical, and effective, eliciting positive responses from students and achieving good learning outcomes. The challenges faced by educators reveal the complexity of managing distance learning, from social factors influencing student participation to technical and instructional barriers. Limitations in implementing printed distance modular learning create additional challenges. On a positive note, distance mathematics learning devices with the PQ4R strategy demonstrate that specific approaches can yield favorable outcomes.

4. Policy and Technical Support Influence on the Utilization of Distance Learning Platforms in Mathematics Education.

Policy and technical support significantly impact the utilization of online mathematics learning platforms. The COVID-19 pandemic has compelled schools to adopt alternative teaching practices, including remote learning, thereby increasing dependence on digital technology (Caratiquit, 2022)). During this period, teachers' confidence in using digital

technology has also seen an increase (Pereira et al., 2020). Furthermore, the availability of technical support directly influences perceptions of ease of use, usefulness, and attitudes toward the platform (Drijvers, et al., 2021). Positive evaluations of online support platforms and the positive attitudes of teachers and students also contribute to the smooth flow of mathematics classes in distance learning (Adamiak, et al., n.d.). However, the implementation of additional learning support interventions in distance learning does not always yield direct or anticipated effects on students' academic achievement (Adyanto & Qadri, 2022). Overall, policy and technical support play a crucial role in facilitating the successful implementation and utilization of distance learning platforms in the context of mathematics education.

The utilization of contextual learning and students' prior knowledge in the context of mathematics education has a significant impact on the development of students' creative thinking skills (Utami, 2017). However, the perception that mathematics is a challenging subject and dissatisfaction with learning outcomes are still commonly observed. The integration of various subjects into thematic learning can enhance the effectiveness of mathematics education (Ami, 2022). Ultimately, the importance of mathematics in everyday life underscores the need for effective teaching strategies and technical support, particularly in the use of distance learning platforms (Ponorogo, 2021).

From the research findings, it is evident that the COVID-19 pandemic has been a primary catalyst for the adoption of distance learning practices in the context of mathematics education. The increased confidence of teachers in using digital technology reflects a positive adaptation to this change. Technical support not only influences teachers' perceptions of distance learning platforms but also plays a crucial role in maintaining the smooth flow of mathematics classes. However, it is important to note that additional support interventions do not always have a direct impact on students' academic achievements. Policies and technical support are considered key elements in the success of mathematics education through distance learning. The increased confidence of teachers and positive evaluations of the platforms indicate success in overcoming the challenges of distance learning. However, it should be noted that the effects of additional support interventions on students' academic achievements may not always align, requiring a more precise approach.

5. Knowledge Gaps or Areas Requiring Further Attention in the Utilization of Distance Learning Platforms in Mathematics Education

The utilization of distance learning platforms in mathematics education has highlighted several knowledge gaps and areas that require further attention. The lack of basic knowledge and confidence among students in mathematics, particularly during the COVID-19 pandemic, has been identified as a significant challenge (Murtiyasa et al., 2023). Connectivity issues and data limitations have also impacted students' engagement with mathematical content in the online learning environment (Jojo, 2022). The readiness of teachers for distance learning and the need for appropriate training in online teaching methods have been emphasized (Novitska, 2023). Social-related challenges and instructor-related challenges have been identified as significant predictors of overall student expectations regarding mathematics learning on online platforms. Transactional aspects of distance learning, such as teacher instruction and

student-teacher communication, were found to be associated with mathematics performance in the mode of delivery of modular distance learning (Torres, 2022).

The utilization of distance learning platforms in the context of mathematics education has identified several knowledge gaps and areas that require further attention. Sunendar, (2017)highlights the importance of problem-solving skills in mathematics education, indicating that these skills should be the primary focus in distance learning. Fredlina, et al. (2020)emphasize the need for a more engaging and enjoyable mathematics learning experience, specifically proposing the utilization of technology to enhance learning. Dusalan, (2018) support this view by advocating the use of teaching aids, such as models and manipulatives, to make the learning process more interactive and enjoyable. Overall, these studies collectively underscore the need for a more engaging and interactive approach to mathematics education in distance learning platforms.

The findings indicate that the utilization of distance learning platforms in mathematics education faces significant challenges, such as students' lack of confidence, connectivity constraints, and both social and instructor-related challenges. The readiness of teachers also emerges as a crucial factor that needs attention to ensure the effectiveness of online learning. These findings illustrate the complexity and diversity of aspects that must be considered in designing and implementing distance mathematics learning. It is essential to acknowledge that these challenges may adversely affect the quality of mathematics learning and student engagement. While some studies have identified these issues, further evaluation is necessary to comprehend their actual impact on student achievement and the overall effectiveness of learning.

6. Potential Enhancements in the Implementation of Distance Learning Platforms

Potential Improvements in the Implementation of Distance Learning Platforms involve providing remote learning training to teachers (Aliyah, et al., 2022), optimizing the use of various learning platforms (Halimah, et al., 2022), enhancing the quality of distance learning by strengthening the role of teachers and learning platforms (Abuhassna et al., 2020), and ensuring the availability of reliable technological infrastructure, adequate equipment, and professional training (Pichugin et al., 2022). Additionally, factors such as students' backgrounds, experiences, collaboration, interaction, and autonomy have a positive influence on student satisfaction with online learning platforms (Kuleshova et al., 2020). The effectiveness of distance learning platforms can be improved by enhancing their usability and addressing existing issues. Effective communication, prompt responsiveness, and automated control systems are also crucial factors for the success of implementing distance learning platforms. Interactivity, simplicity, convenience, speed of interaction between students and teachers, platform flexibility, and quality control are key elements contributing to the effectiveness of distance learning platforms.

The application of diverse teaching and learning strategies has the potential to enhance the quality of distance learning platforms. Widiyanto (2020) emphasizes the significance of instructional planning to achieve effective teaching, which can be applied in the context of distance learning. Pratiwi highlights the utilization of local cultural potential in science education, which can be integrated into distance learning to make it more engaging and

meaningful. Nurhana, et al. (2022), both discuss the implementation of integrated learning models and contextual approaches, respectively, that can be adapted to distance learning to foster creativity and active learning. Overall, these studies suggest that the effective implementation of these strategies can enhance the quality of distance learning.

The research findings indicate that improving the implementation of distance learning platforms can be achieved through several strategies. Training in distance learning for teachers, optimizing platform usage, strengthening the role of teachers, and investing in technology infrastructure are key factors in enhancing the effectiveness of distance learning. Furthermore, elements such as student backgrounds, interaction, and autonomy are also identified as variables that can increase student satisfaction with online learning platforms. The cited studies present a balanced and holistic perspective on improving the implementation of distance learning platforms. The focus on teacher training, platform optimization, strengthening the role of teachers, and infrastructure enhancement provides a comprehensive approach. The research results offer an in-depth understanding of various factors that can influence the effectiveness of distance learning, ranging from technical aspects to students' psychosocial factors.

D. CONCLUSIONS AND SUGGESTIONS

Based on the evaluation of research results regarding the implementation of distance learning platforms in the context of mathematics education, it is identified that serious challenges are faced by teachers, students, and parents. Factors such as technical difficulties, low student motivation, and limitations in environmental support are significant obstacles. Nevertheless, there is potential for improvement through teacher training, platform optimization, strengthening the role of teachers, and infrastructure investment. Knowledge gaps that emerge involve students' lack of basic understanding, connectivity challenges, as well as teacher readiness and training. Therefore, an urgent research topic for the future is "Development of a Holistic Distance Learning Model for Mathematics: Integrating Teacher Training, Platform Optimization, and Student Psychosocial Factors." This research can explore ways to align more effective teacher training, enhance the design of learning platforms, and address students' psychosocial challenges to improve the effectiveness of distance learning in mathematics.

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