

# Revolutionizing Mathematics Education in the 5.0 Era: Exploring Future-Ready Media Requirements and Competencies for Aspiring Educators

**Torang Siregar\***

Mathematics Education Lecturer at Syekh Ali Hasan Ahmad Addary State Islamic University  
Padangsidempuan, North Sumatra, Indonesia

[torangsir@uinsyahada.ac.id](mailto:torangsir@uinsyahada.ac.id)

**Almira Amir**

Postgraduate Lecturer in Mathematics Education at Syekh Ali Hasan Ahmad Addary State  
Islamic University Padangsidempuan, North Sumatra, Indonesia

[almiraamir@uinsyahada.ac.id](mailto:almiraamir@uinsyahada.ac.id)

**Suparni**

Postgraduate Lecturer in Mathematics Education at Syekh Ali Hasan Ahmad Addary State  
Islamic University Padangsidempuan, North Sumatra, Indonesia

[suparni@uinsyahada.ac.id](mailto:suparni@uinsyahada.ac.id)

**Anita Adinda**

Postgraduate Lecturer in Mathematics Education at Syekh Ali Hasan Ahmad Addary State  
Islamic University Padangsidempuan, North Sumatra, Indonesia

[anitaadinda@uinsyahada.ac.id](mailto:anitaadinda@uinsyahada.ac.id)

## ***Abstract***

*In the 5.0 era, the rapid advancement of technology has transformed educational practices, especially in mathematics education. Aspiring educators must not only master mathematical concepts but also develop competencies in utilizing future-ready media that enhance teaching and learning effectiveness. This study explores the perceptions of prospective teachers regarding the media requirements necessary for revolutionizing mathematics education in the 5.0 era. Using a descriptive qualitative approach, the research surveyed 50 students from the Madrasah Ibtidaiyah Teacher Education (PGMI) program at a university in Padangsidempuan. Data were collected through a questionnaire, followed by data reduction, presentation, and conclusion drawing. The findings reveal that the integration of advanced media in mathematics education is critical for creating an engaging and efficient learning environment. Teachers, as the main facilitators of the learning process, must be adept at selecting and employing media that aligns with students' needs, curriculum content, and the demands of modern technology. In the context of 21st-century education, future educators are required to be competent in using digital tools and innovative learning platforms to foster critical thinking, creativity, and problem-solving skills among students. The study concludes that future-ready media play a vital role in enhancing the quality of mathematics education, and aspiring teachers must be equipped with the necessary skills and competencies to effectively integrate these media into their teaching practices. This will enable them to meet the challenges of educating students in a highly digitalized and interconnected world.*

**Keywords:** 5.0 Era, Future Learning Media, Teacher Competencies, Mathematics Education, Technological Integration.

## Abstrak

Di era 5.0, kemajuan teknologi yang pesat telah mengubah praktik pendidikan, terutama dalam pendidikan matematika. Calon pendidik tidak hanya dituntut untuk menguasai konsep-konsep matematika, tetapi juga harus mengembangkan kompetensi dalam memanfaatkan media masa depan yang siap digunakan untuk meningkatkan efektivitas pembelajaran. Penelitian ini mengeksplorasi persepsi calon guru terhadap kebutuhan media yang diperlukan untuk merevolusi pendidikan matematika di era 5.0. Dengan pendekatan deskriptif kualitatif, penelitian ini melakukan survei terhadap 50 mahasiswa Program Pendidikan Guru Madrasah Ibtidaiyah (PGMI) di sebuah universitas di Padangsidimpuan. Pengumpulan data dilakukan melalui angket, diikuti dengan reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa integrasi media canggih dalam pendidikan matematika sangat penting untuk menciptakan lingkungan belajar yang menarik dan efisien. Guru, sebagai fasilitator utama dalam proses pembelajaran, harus mampu memilih dan menggunakan media yang sesuai dengan kebutuhan siswa, konten kurikulum, serta tuntutan teknologi modern. Dalam konteks pendidikan abad ke-21, calon guru diharapkan kompeten dalam menggunakan alat digital dan platform pembelajaran inovatif untuk mendorong pemikiran kritis, kreativitas, dan keterampilan pemecahan masalah di kalangan siswa. Penelitian ini menyimpulkan bahwa media yang siap untuk masa depan memainkan peran penting dalam meningkatkan kualitas pendidikan matematika, dan calon guru harus dibekali dengan keterampilan dan kompetensi yang diperlukan untuk mengintegrasikan media ini secara efektif dalam praktik pengajaran mereka. Hal ini akan memungkinkan mereka menghadapi tantangan mendidik siswa di dunia yang semakin digital dan saling terhubung.

**Kata Kunci:** Era 5.0, Media Pembelajaran Masa Depan, Kompetensi Guru, Pendidikan Matematika, Integrasi Teknologi.

## INTRODUCTION

The Fourth Industrial Revolution, or Industry 5.0, has significantly influenced various sectors, reshaping industries and impacting everyday life. In this era, advanced technologies such as artificial intelligence, big data, the Internet of Things (IoT), and robotics have become essential components of global economic and social systems (Kade et al., 2022). These technologies enable the automation of processes, improve efficiency, and enhance innovation in multiple industries. The shift from traditional to digital platforms has created a new landscape where technology drives productivity, communication, and even human interaction. The rapid technological advancements we are experiencing have introduced a new era of digital integration, fundamentally altering how industries operate and how people engage with the world around them (Kade et al., 2022). The industrial sectors, in particular, have adapted to this evolution by leveraging automation and intelligent systems to meet the growing demands of the global market.

As we continue to navigate the Fourth Industrial Revolution, we find ourselves in a time marked by constant technological change. This era is characterized by rapid advancements in digital technologies, which have transformed the way we work, communicate, and learn (Nabilah et al., 2021). With the proliferation of mobile devices, cloud computing, and high-speed internet, technology has become an indispensable part of modern life. These innovations have not only improved access to information but have also revolutionized how we approach daily tasks, from shopping and entertainment to education

and business operations. The digitalization of services has created a more interconnected and efficient world, where information is accessible at the click of a button, and the boundaries between the physical and virtual realms are increasingly blurred (Nabilah et al., 2021). The integration of technology into various sectors has made it possible for individuals and organizations to optimize their operations and expand their reach in ways that were previously unimaginable.

Technology has become so deeply embedded in modern life that it is now impossible to imagine a world without it (Alim et al., 2023). In every facet of society, from healthcare to transportation, technology plays a critical role in shaping our experiences and interactions. It has enabled us to live in a world where digital platforms facilitate communication, commerce, and collaboration on a global scale. The digital transformation of society has led to the rise of smart cities, connected devices, and digital infrastructures that support real-time data collection and analysis. This has allowed for greater efficiency and innovation in managing resources, providing services, and solving complex problems (Alim et al., 2023). As a result, individuals and organizations are increasingly reliant on technology to navigate the complexities of modern life, and this reliance is expected to grow as new technologies continue to emerge and evolve.

The Fourth Industrial Revolution has not only impacted industries but has also left a profound mark on education, leading to the rise of what is now known as Education 5.0. Education 5.0 is a response to the demands of the digital age, where technology is integrated into the learning process to enhance both teaching and learning experiences (Oktaviani et al., 2022). The traditional model of education, which was primarily focused on rote learning and memorization, is gradually being replaced by a more dynamic and interactive approach, where students are encouraged to engage with digital tools and resources. In Education 5.0, learners are empowered to take control of their own education, using technology to access information, collaborate with peers, and develop critical thinking skills. This shift towards a more personalized and technology-driven education system is designed to prepare students for the challenges of the modern workforce, where digital literacy and adaptability are essential (Oktaviani et al., 2022). The integration of technology into education has not only enhanced the learning experience but has also made it more accessible to students around the world, breaking down geographical and socioeconomic barriers.

In the context of the Fourth Industrial Revolution, the role of educators is also evolving. Teachers are no longer just providers of knowledge but facilitators of learning, guiding students in navigating the digital landscape and developing the skills necessary for success in the 21st century (Kade et al., 2022). As technology continues to reshape the way we live and work, educators must adapt to these changes by incorporating digital tools and innovative teaching methods into their classrooms. This requires a shift from traditional teaching practices to more flexible and student-centered approaches, where the focus is on fostering creativity, problem-solving, and collaboration. Educators must also stay updated with the latest technological advancements and be prepared to integrate them into their teaching practices, ensuring that students are equipped with the digital skills they need to thrive in a rapidly changing world (Kade et al., 2022). The ability to adapt to new technologies and teaching methods will be critical for educators as they prepare students for the demands of the Fourth Industrial Revolution.

One of the key challenges of Education 5.0 is ensuring that students are not only proficient in using technology but also able to think critically and creatively in applying these tools to solve real-world problems. The goal of Education 5.0 is not just to teach students

how to use technology but to empower them to become innovators and problem solvers in a digital age (Nabilah et al., 2021). This requires a shift in educational priorities, where the development of soft skills such as creativity, communication, and collaboration is given equal importance to technical skills. In this new paradigm, students are encouraged to take an active role in their learning, using technology as a tool to explore new ideas, experiment with different approaches, and collaborate with others to find solutions to complex problems (Nabilah et al., 2021). By fostering these skills, Education 5.0 aims to produce a generation of learners who are not only proficient in using technology but also capable of leading and innovating in a technology-driven world.

In addition to enhancing student engagement and learning outcomes, Education 5.0 also has the potential to create more inclusive and equitable learning environments. Technology can be a powerful tool in bridging educational gaps, providing access to quality education for students in remote or underserved areas (Alim et al., 2023). Through online learning platforms, virtual classrooms, and digital resources, students can access a wide range of educational materials, regardless of their location or socioeconomic background. This has the potential to democratize education, ensuring that all students have the opportunity to learn and succeed in a digital world. However, the successful implementation of Education 5.0 requires careful planning and investment in digital infrastructure, teacher training, and student support systems to ensure that all students can benefit from these technological advancements (Alim et al., 2023). Without these supports, there is a risk that the digital divide could widen, leaving some students behind in an increasingly digitalized education system.

As we move further into the Fourth Industrial Revolution, it is clear that technology will continue to play a central role in shaping the future of education. The integration of digital tools and resources into the learning process is not just a trend but a fundamental shift in how education is delivered and experienced (Oktaviani et al., 2022). As technology continues to evolve, so too will the methods and approaches used in education. The future of education will likely be characterized by a greater emphasis on personalized learning, where students can learn at their own pace and in their own way, using technology to access a wealth of information and resources (Oktaviani et al., 2022). This shift towards more flexible and individualized learning experiences will require educators to rethink traditional teaching methods and embrace new approaches that leverage the power of technology to enhance learning outcomes.

In conclusion, the Fourth Industrial Revolution has had a profound impact on various sectors, including education. The rise of Education 5.0 represents a new era in teaching and learning, where technology plays a central role in shaping the educational experience (Kade et al., 2022). The integration of digital tools and resources into the classroom has the potential to enhance student engagement, improve learning outcomes, and create more inclusive and equitable educational opportunities. However, the successful implementation of Education 5.0 requires careful planning, investment in digital infrastructure, and ongoing professional development for educators to ensure that they are equipped with the skills and knowledge needed to effectively integrate technology into their teaching practices. As we continue to navigate the challenges and opportunities of the Fourth Industrial Revolution, it is clear that technology will play a central role in shaping the future of education (Kade et al., 2022; Nabilah et al., 2021; Alim et al., 2023; Oktaviani et al., 2022).

We are currently in the 21st century, where education is expected to prepare individuals to face the challenges of the Fourth Industrial Revolution by providing relevant

skills and utilizing technology in the learning process. Education in this era is no longer confined by space and time, as digital technology is incorporated into teaching and learning activities (Makaruku & Makulua, 2021). In this context, schools must be able to leverage and adapt to these technological advancements (Yunus & Mitrohardjono, 2020). Therefore, innovation is needed in the field of education, including innovative models of instruction, teaching strategies, and learning media. Teachers must create learning environments that capture students' attention and provide an enjoyable experience (Setyawan et al., 2020).

In the 21st century, education plays a crucial role in preparing individuals to navigate the complexities of the Fourth Industrial Revolution. This revolution brings unprecedented challenges, demanding that people develop skills such as critical thinking, problem-solving, and technological literacy (Makaruku & Makulua, 2021). To meet these demands, education must evolve, moving beyond traditional methods that rely heavily on lectures and memorization. Instead, it should embrace a more dynamic, student-centered approach that incorporates technology into every aspect of the learning process. Digital tools, online platforms, and interactive software allow education to break free from the constraints of physical classrooms and fixed schedules, offering flexibility and accessibility that were previously unimaginable (Makaruku & Makulua, 2021).

This shift in educational paradigms means that learning can now take place anytime and anywhere, allowing students to access knowledge from various sources beyond textbooks and classroom walls. The rise of e-learning platforms, virtual classrooms, and blended learning environments illustrates the extent to which education has adapted to the digital age (Yunus & Mitrohardjono, 2020). In this context, schools are tasked with the responsibility of integrating technology into the learning experience effectively. Rather than simply digitizing traditional teaching methods, schools must adopt innovative practices that use technology to enhance student engagement and learning outcomes (Yunus & Mitrohardjono, 2020).

The integration of technology into education requires a rethinking of how instruction is delivered. Educators must now design learning experiences that actively engage students, making use of multimedia tools, simulations, and interactive activities to make learning more immersive and effective (Setyawan et al., 2020). This shift is especially important as today's students, often referred to as digital natives, are accustomed to interacting with technology in their everyday lives. By incorporating technology into lessons, educators can create more relatable and engaging content that resonates with students' experiences and expectations (Setyawan et al., 2020).

At the core of this educational transformation is the need for innovation. Schools and educators must continually explore and implement new teaching models that leverage technology to meet the diverse needs of students. This might include flipped classrooms, where students engage with learning materials online before coming to class for discussion and application, or project-based learning, where students use technology to research and solve real-world problems (Makaruku & Makulua, 2021). Such models not only provide students with relevant, hands-on learning experiences but also equip them with the digital skills they need to succeed in a rapidly changing world.

The role of the teacher in this digital era also changes dramatically. Rather than simply dispensing information, teachers now act as facilitators of learning, guiding students as they explore, experiment, and engage with digital tools. Teachers must create learning environments that are not only informative but also interactive and enjoyable, encouraging students to take an active role in their education (Setyawan et al., 2020). This requires

teachers to be innovative in their use of teaching strategies and learning media, ensuring that lessons capture students' attention and cater to different learning styles.

As the Fourth Industrial Revolution continues to evolve, so too must the education systems that prepare individuals for this new reality. The challenge lies in ensuring that educational practices and policies keep pace with technological advancements, providing students with the knowledge and skills they need to thrive in a digitally-driven world (Yunus & Mitrohardjono, 2020).

One subject that is often challenging to teach for elementary school teachers and difficult for students to understand is mathematics (Fauzi et al., 2020). Students often perceive mathematics as a difficult and unenjoyable subject. This presents a unique challenge for teachers to create engaging and enjoyable mathematics lessons. Therefore, extra attention from teachers is necessary for this subject, including for prospective elementary schoolteachers.

Mathematics has long been considered one of the most challenging subjects for both students and teachers, particularly at the elementary school level. This difficulty often stems from the abstract nature of mathematical concepts, which can be hard for young learners to grasp. Studies, such as those by Fauzi et al. (2020), have shown that many students perceive mathematics as not only difficult but also unenjoyable. This perception can create a significant barrier to learning, as students who struggle with the subject are less likely to engage with the material and may even develop a long-lasting aversion to mathematics. This highlights the importance of effective teaching strategies and the need for teachers to make mathematics lessons more engaging and accessible to students.

For elementary school teachers, especially those who are in training, this poses a considerable challenge. Teaching mathematics requires more than just an understanding of the subject matter; it also demands creativity and skill in making the material relatable and enjoyable for students. Teachers must be able to present mathematical concepts in ways that resonate with their students' experiences and learning styles. This often means finding innovative ways to explain abstract ideas and incorporating hands-on activities, games, or visual aids to make learning more interactive and fun (Fauzi et al., 2020).

Prospective teachers, in particular, need to be prepared for this challenge. They must not only master the content of elementary mathematics but also learn how to effectively communicate these concepts to young learners. Teacher education programs must therefore place a strong emphasis on developing both the content knowledge and pedagogical skills of future teachers. This includes providing them with tools and strategies for making mathematics more engaging, such as using manipulatives, integrating technology, and employing problem-solving activities that encourage critical thinking and collaboration (Fauzi et al., 2020).

Moreover, creating a positive attitude towards mathematics in the classroom is essential. Teachers need to foster a learning environment where students feel comfortable asking questions and making mistakes, as these are crucial aspects of the learning process. Encouraging a growth mindset, where students understand that their abilities in mathematics can improve with effort and persistence, is also vital in helping them overcome their fear of the subject. By building students' confidence and reducing their anxiety around mathematics, teachers can help create a more positive and productive learning experience (Fauzi et al., 2020).

The importance of this issue extends beyond the classroom, as mathematical literacy is essential for many aspects of daily life and future careers. A strong foundation in

mathematics is critical not only for students' academic success but also for their ability to navigate an increasingly complex and data-driven world. As such, teachers have a responsibility to ensure that students develop the skills and confidence they need to apply mathematical thinking to real-life situations.

In conclusion, the challenge of teaching mathematics in elementary schools is significant, but it is not insurmountable. With the right approaches, teachers can transform mathematics from a subject that students dread into one that they enjoy and excel in. For prospective teachers, understanding the difficulties students face in learning mathematics and acquiring the skills to address these challenges is key. By making mathematics more engaging and accessible, teachers can help foster a generation of students who not only perform well in the subject but also appreciate its value in their everyday lives (Fauzi et al., 2020).

As future elementary school teachers, their role is crucial. Prospective elementary school teachers are expected to learn and keep up with technological advancements. They must innovate in the use of learning media and be able to use or create media that aligns with the characteristics of elementary school students. This is because classroom learning today goes beyond traditional textbooks; it requires instructional media as supportive tools (Hidayati & Irmawati, 2019).

The role of prospective elementary school teachers is critical in shaping the educational experiences of young learners. As future educators, they are tasked with not only imparting knowledge but also fostering a learning environment that is engaging and conducive to the development of essential skills. One of the key expectations for these teachers is to stay informed about and adept at using technological advancements in their teaching practices. In an era where digital technology is increasingly integrated into education, it is vital for prospective teachers to understand how to effectively incorporate these tools into their lesson plans (Hidayati & Irmawati, 2019).

Innovation in the use of learning media is paramount. Traditional textbooks, while still valuable, no longer suffice in fully meeting the diverse learning needs of today's students. Instead, a variety of instructional media—including videos, interactive applications, and online resources—are now essential components of effective teaching. These tools can enhance engagement, cater to different learning styles, and provide opportunities for hands-on experiences that make learning more dynamic and relevant (Hidayati & Irmawati, 2019).

Prospective teachers must be capable of not only utilizing existing educational technologies but also creating their own media that resonate with the characteristics of elementary school students. Understanding the developmental stages of young learners is crucial; teachers need to design materials that are age-appropriate, stimulating, and aligned with their students' interests and cognitive abilities. For instance, incorporating gamification elements or interactive storytelling into lessons can make complex concepts more relatable and enjoyable for children.

Furthermore, the integration of technology in the classroom allows for greater flexibility and personalized learning experiences. Teachers can use data from digital tools to assess students' progress and tailor their instruction accordingly. This approach not only supports differentiated learning but also empowers students to take ownership of their educational journeys. As a result, they become more engaged and motivated learners, better equipped to tackle the challenges they will face in the future (Hidayati & Irmawati, 2019).

The importance of teacher preparedness in utilizing technology and innovative learning media cannot be overstated. Teacher education programs must prioritize equipping

future educators with the necessary skills and knowledge to navigate the evolving landscape of educational technology. This includes offering training on various digital tools, instructional design principles, and strategies for integrating technology into the curriculum effectively. By fostering a mindset of lifelong learning, prospective teachers will be better prepared to adapt to the rapid changes in educational practices and technologies throughout their careers.

In conclusion, as future elementary school teachers, the responsibility to innovate and effectively use learning media is paramount. Embracing technological advancements and creating relevant instructional materials can significantly enhance the educational experience for elementary school students. By doing so, prospective teachers not only enrich their teaching practices but also contribute to the development of students who are better prepared for the demands of the 21st century (Hidayati & Irmawati, 2019).

Elementary school teachers or prospective teachers need to have knowledge and understanding of students' learning media needs. They should be innovative in creating or using mathematics learning media that capture students' attention and provide an enjoyable learning experience. When students feel happy and engaged in their learning, they become more interested and motivated to learn (Faradila & Aimah, 2018).

Elementary school teachers, as well as those who are in training to become teachers, play a critical role in shaping the learning experiences of young students. To effectively facilitate learning, it is essential for them to possess a deep understanding of their students' learning media needs. Knowledge of how students learn, what engages them, and how they respond to different types of media is foundational for creating effective educational experiences. Teachers should recognize that each student is unique, with distinct preferences, learning styles, and interests. Therefore, it is crucial for educators to be adaptive and responsive, tailoring their instructional strategies to meet the diverse needs of their students.

Innovation is key in this process, particularly in the context of teaching mathematics, which can often be perceived as a challenging subject by young learners. Creating or using mathematics learning media that captures students' attention is paramount. This could involve integrating technology, such as interactive software, educational games, or multimedia presentations, that make mathematical concepts more tangible and engaging. By doing so, teachers can provide an enjoyable learning experience that fosters curiosity and a love for mathematics. When students feel happy and engaged in their learning, they become more interested and motivated to learn, which ultimately enhances their academic performance and confidence in their abilities (Faradila & Aimah, 2018).

Understanding the importance of student engagement in learning is supported by various educational theories, such as constructivism. This theory posits that learners construct their own understanding and knowledge of the world through experiences and reflecting on those experiences (Piaget, 1973). In this light, teachers must create a learning environment that encourages exploration, experimentation, and active participation. Utilizing a variety of learning media allows students to engage with mathematical concepts in different ways, accommodating various learning styles and preferences. For instance, visual learners may benefit from diagrams and videos, while kinesthetic learners might excel through hands-on activities that allow them to manipulate materials.

Moreover, the use of diverse learning media can help bridge gaps in understanding and provide multiple entry points for students struggling with mathematical concepts. For example, incorporating games that involve problem-solving can make learning math less intimidating and more enjoyable. This approach aligns with the principles of differentiated

instruction, which emphasizes tailoring teaching environments and practices to create appropriate learning experiences for all students (Tomlinson, 2001). Teachers who embrace this philosophy are more likely to meet the varied needs of their students, helping them to achieve their full potential in mathematics.

Another significant aspect of understanding students' learning media needs is the role of feedback. Teachers should use formative assessments to gauge how well their students are grasping mathematical concepts and to determine which media are most effective in facilitating learning. This ongoing process of assessment and reflection enables teachers to adjust their instructional strategies and media use in real-time, ensuring that they are meeting their students' needs effectively. Moreover, when students receive timely and constructive feedback, they are better positioned to understand their strengths and areas for improvement. This practice fosters a growth mindset, which is crucial for developing resilience and persistence in learning (Dweck, 2006).

In addition to traditional and digital learning media, teachers should also consider the importance of collaborative learning experiences. Group activities and discussions can provide students with opportunities to share ideas, solve problems together, and learn from one another. This social interaction is essential for developing communication skills and building a supportive classroom community. Furthermore, collaborative learning can enhance students' understanding of mathematical concepts by allowing them to articulate their thought processes and reasoning. When students engage in meaningful dialogue about math, they are more likely to deepen their comprehension and retention of the material.

Importantly, the integration of culturally relevant materials in mathematics education can enhance student engagement and connection to the subject. When students see their own cultures and experiences reflected in the learning materials, they are more likely to feel valued and motivated to participate. This approach aligns with the principles of culturally responsive teaching, which emphasizes the importance of incorporating students' cultural backgrounds into the curriculum (Ladson-Billings, 1994). By doing so, teachers can create a more inclusive and affirming learning environment that fosters a sense of belonging among all students.

In conclusion, the knowledge and understanding of students' learning media needs are essential for elementary school teachers and prospective teachers. Their ability to innovate and create engaging mathematics learning media can significantly impact students' motivation and interest in the subject. As educators, it is their responsibility to ensure that students experience mathematics as an enjoyable and rewarding discipline. By leveraging diverse learning media, employing differentiated instruction, providing constructive feedback, promoting collaborative learning, and incorporating cultural relevance, teachers can create a rich and supportive educational environment. This holistic approach ultimately leads to improved student outcomes in mathematics and lays the foundation for lifelong learning and appreciation of the subject (Faradila & Aimah, 2018).

As elementary school teachers or prospective teachers, they must have knowledge and understanding of the learning media needs that align with students' characteristics and keep up with the changing times. Learning media is crucial in the teaching and learning process in the classroom (Nurfadhillah, Cahya Tri Ramadani, et al., 2021; Saddam Husein, 2018; G. W. Utomo et al., 2022). Therefore, the perceptions of teachers, prospective teachers, and elementary school students regarding this matter are important. Perceptions play a vital role in learning, as they reflect an individual's assessment and understanding (Mania & Alam, 2021). Perceptions represent someone's perspective in solving a given

problem (Margot & Kettler, 2019). Hence, this article examines the perceptions prospective teachers regarding the Future-Ready Media Demands among Aspiring Educators.

As elementary school teachers or prospective teachers, it is essential to have a comprehensive understanding of the learning media needs that align with students' characteristics and adapt to the rapidly changing educational landscape. In the 21st century, the integration of technology in education has transformed the way students learn and interact with content. Learning media serves as a crucial component in the teaching and learning process within the classroom, acting as a bridge between abstract concepts and students' understanding (Nurfadhillah, Cahya Tri Ramadani, et al., 2021; Saddam Husein, 2018; G. W. Utomo et al., 2022). With the advent of digital tools and resources, it has become increasingly important for educators to utilize diverse media that resonate with the learning preferences of their students.

Understanding the perceptions of teachers, prospective teachers, and elementary school students regarding learning media is pivotal. These perceptions significantly influence how effectively educational media are integrated into instruction and how students engage with learning materials. Perceptions play a vital role in learning, as they reflect an individual's assessment and understanding of their environment and experiences (Mania & Alam, 2021). Teachers and students interpret and respond to various media in distinct ways based on their backgrounds, experiences, and cognitive styles. Therefore, recognizing these perceptions can provide valuable insights into how to enhance the learning experience through tailored media selection.

Moreover, perceptions represent an individual's perspective in solving a given problem, highlighting the subjective nature of learning experiences (Margot & Kettler, 2019). This subjectivity underscores the importance of incorporating students' voices in the selection and use of learning media. Engaging students in discussions about their preferences for learning materials can lead to a more inclusive and effective educational environment. When students feel their opinions are valued, they are more likely to take ownership of their learning and remain engaged in the process. Thus, the examination of perceptions among prospective teachers regarding Future-Ready Media Demands is crucial for informing instructional practices and ensuring that learning media are aligned with the needs of today's learners.

Furthermore, understanding these perceptions can also guide teacher training programs in equipping future educators with the skills necessary to navigate the evolving landscape of education. By fostering awareness of the diverse learning media available and encouraging innovative approaches to teaching, teacher preparation programs can better prepare aspiring educators to meet the challenges of the modern classroom. This proactive approach not only enhances the quality of education but also promotes the development of critical thinking and problem-solving skills among future teachers.

In summary, the exploration of perceptions related to learning media is essential for both current and prospective elementary school teachers. Recognizing the significance of these perceptions can lead to improved teaching strategies and more meaningful learning experiences for students. By understanding and responding to the diverse needs of students, educators can create engaging and effective learning environments that prepare young learners for success in the 21st century. This article aims to delve into the perceptions of prospective teachers regarding Future-Ready Media Demands among Aspiring Educators, providing insights that can inform future educational practices and policies.

## METHOD

This study employs a qualitative descriptive research approach utilizing a survey method, aiming to describe the perceptions of prospective teachers regarding the need for revolutionizing mathematics education in the 5.0 era. Specifically, it explores the future-ready media requirements and competencies essential for aspiring educators. The sample for this research consists of 50 prospective elementary school teacher education students from a university located in Padangsidempuan City, North Sumatera, Indonesia. This group was selected to provide insights into how future educators perceive the integration of innovative media and technology in mathematics instruction.

The research design incorporates several key components, starting with the formulation of the research problem. This step is crucial as it defines the focus of the study, guiding the development of the survey and the subsequent data collection process. The research questions are crafted to elicit detailed responses from participants regarding their perceptions and experiences related to the use of learning media in mathematics education.

Data collection is conducted through a structured questionnaire, which is designed to capture a comprehensive view of the participants' perspectives. The questionnaire focuses on two primary factors: functional and structural.

Functional factors address the practical aspects of learning media, including their usability, effectiveness, and relevance to the curriculum. This dimension is vital as it helps identify the specific types of media that prospective teachers believe will enhance student engagement and understanding in mathematics. By assessing functional factors, the study seeks to uncover which media are considered most beneficial in facilitating effective learning experiences.

In contrast, structural factors pertain to the organizational and systemic elements that support the implementation of learning media in educational settings. This includes considerations such as the availability of technological resources, institutional support for training teachers in the use of these media, and alignment with educational standards. Understanding these structural factors is essential for identifying potential barriers and facilitators in the integration of innovative media into mathematics instruction.

The data collection process involves administering the questionnaire to the sample group, who provide responses based on their insights and experiences regarding learning media in their prospective teaching careers. Once data collection is completed, the analysis phase begins, where the responses are organized, categorized, and interpreted to reveal patterns and themes related to the perceptions of prospective teachers.

In summary, the methodology of this study, characterized by qualitative descriptive research and a survey approach, is designed to provide a comprehensive understanding of the perceptions of prospective teachers. By focusing on both functional and structural factors, this research aims to contribute valuable insights into the future-ready media requirements and competencies essential for revolutionizing mathematics education in the 5.0 era.

**Table 1.**

Perceptions of Prospective Teachers Indicators Regarding the Need for Mathematics Learning Media in The Digital Era

Factor	Indicator
Functional	Clarifying the presented material
	Facilitating the learning process

	Providing systematic and logical delivery of the material
	Enhancing the ability to understand the material
Structural	Streamlining the learning process
	Using time efficiently
	Relevance to the current era

### Functional and Structural Factors in Mathematics Education

In the context of revolutionizing mathematics education, it is essential to examine both functional and structural factors that influence the effectiveness of learning media. Functional factors are those that directly impact the way educational content is presented and understood by students. For instance, clarifying the presented material is a critical function of effective learning media, as it helps students grasp complex mathematical concepts more easily. Additionally, learning media should facilitate the learning process, making it more interactive and engaging for students. This engagement can enhance the students' ability to understand the material, allowing for a deeper comprehension of mathematical ideas.

Another vital aspect of functional factors is the provision of a systematic and logical delivery of the material. When mathematical content is presented in a structured manner, students can follow the progression of ideas more clearly, which is crucial for building a solid foundation in mathematics. Therefore, the functional factors play a significant role in shaping how students perceive and interact with mathematical content.

On the other hand, structural factors refer to the broader organizational elements that support the implementation of learning media in educational settings. Streamlining the learning process is a key structural factor that can significantly impact how effectively mathematics is taught. This involves ensuring that the learning environment is conducive to the adoption of new media and methodologies. Efficient use of time during lessons is another critical structural factor, as it allows teachers to maximize instructional time while maintaining student engagement.

Moreover, the relevance of learning media to the current era cannot be overlooked. In the rapidly changing landscape of education driven by technological advancements, it is essential that the media used in teaching mathematics aligns with contemporary trends and the needs of students. This alignment not only enhances the learning experience but also prepares students to thrive in a world increasingly influenced by technology.

In summary, understanding both the functional and structural factors is vital for prospective teachers as they prepare to revolutionize mathematics education in the 5.0 era. By focusing on these indicators, educators can create an engaging and effective learning environment that meets the needs of today's students while also equipping them with the skills necessary for the future. Then, the processed data will be converted into intervals (Table 2).

**Table 2.**

Conversion of Mathematics Learning Media Needs Questionnaire

Interval (%)	Interpretation
$80.0 \leq X \leq 100.0$	High
$60.0 \leq X < 80.0$	Moderate
$X < 60.0$	Low

Source: Buranda & Bernard (2022)

### Conversion of Mathematics Learning Media Needs Questionnaire

The evaluation of the Mathematics Learning Media Needs Questionnaire is essential for understanding the perceptions of prospective teachers regarding the necessary resources for effective mathematics instruction. The responses gathered from the questionnaire are converted into an interval percentage format to interpret the findings systematically. This approach provides clarity on the level of need for various learning media in the context of revolutionizing mathematics education.

According to the established criteria for interpretation, the results are classified into three distinct categories based on the calculated percentages:

1. High Needs ( $80.0 \leq X \leq 100.0$ ): This category indicates a strong demand for specific mathematics learning media. When the percentage falls within this range, it reflects that the prospective teachers believe that these media are crucial for enhancing the learning experience. A high score suggests that the identified resources are perceived as highly effective in facilitating understanding and engagement among students. Therefore, educational stakeholders should prioritize these media in curriculum design and teacher training programs.
2. Moderate Needs ( $60.0 \leq X < 80.0$ ): A moderate score indicates that there is a reasonable demand for the learning media, though it may not be viewed as essential. This range signifies that while the media is considered beneficial, there may be other factors influencing its necessity. Teachers and educational institutions should pay attention to these moderate needs, as they could be indicative of areas where improvement is possible, ensuring that the media aligns with the evolving demands of mathematics education.
3. Low Needs ( $X < 60.0$ ): Scores in this category suggest a low perception of necessity for the specific learning media assessed. When prospective teachers indicate a low need for certain resources, it may signal that these media are either not relevant to current teaching practices or that alternative methods are preferred. Educational planners should investigate these low needs further to understand the underlying reasons, as this insight can guide the development of more effective instructional strategies that resonate with both teachers and students.

This interpretative framework is adapted from Buranda & Bernard (2019), and it serves as a guideline for analyzing the responses from the Mathematics Learning Media Needs Questionnaire. By categorizing the needs based on these intervals, educators and researchers can better understand the priorities for developing future-ready media that aligns with the demands of 21st-century mathematics education.

After the data collection, data analysis is collection, data analysis, and conclusion drawing. The data collection instrument used in the study is a questionnaire. Data collection techniques involve using a Likert scale questionnaire through Google Forms distributed to prospective elementary school teachers. The results obtained from the questionnaire and interviews will be processed and used to obtain information regarding the perceptions of teachers, prospective teachers, and students regarding the need for mathematics learning media in the digital era. Two factors related to the need for learning media are used as reference points in the research conducted. The data analysis technique used in this research follows the steps proposed by Miles and Huberman (Sugiyono, 2019). These steps

consist of three phases: Data Reduction, Data Display, and Conclusion Drawing. By following these steps, a comprehensive analysis of the collected data can be achieved, leading to a deeper understanding of the research topic.

## **RESULTS AND DISCUSSION**

### **RESULTS**

Data on prospective teachers' perceptions of the need for mathematics learning media in elementary schools were collected through a survey questionnaire distributed via Google Form. The questionnaire was administered to a sample of 50 students majoring in elementary school teaching. This approach not only facilitated efficient data collection but also ensured the participation of a diverse group of respondents, reflecting a broad range of perspectives on the use of learning media in mathematics education.

The data collected from the questionnaire provided valuable insights into how prospective teachers perceive the necessity of various types of mathematics learning media. The results are summarized in Table 3, which presents the perceived needs for different categories of learning media. This table categorizes the responses based on the established criteria for interpreting the data, which include high, moderate, and low needs (Buranda & Bernard, 2019).

Upon analyzing the results presented in Table 3, several trends emerged regarding the types of learning media that prospective teachers deem essential for effective mathematics instruction. A notable finding is that a majority of respondents expressed a high need for interactive digital media, such as educational software, apps, and online learning platforms. This preference underscores a growing recognition among future educators of the importance of engaging students through technology. Interactive media can significantly enhance the learning experience by making complex mathematical concepts more accessible and enjoyable for young learners.

In contrast, traditional media, such as textbooks and printed worksheets, were rated with a moderate level of necessity. This indicates that while these resources remain important, their effectiveness may be diminished in the context of contemporary educational practices. The moderate perception of traditional media suggests that prospective teachers are aware of the limitations of these resources and are seeking more innovative approaches to teaching mathematics.

Furthermore, certain learning media were identified as having a low perceived need. These findings highlight a critical gap in the educational resources currently employed in mathematics instruction. The low rating for some traditional methods suggests that they may not be effectively meeting the needs of today's students, who are increasingly exposed to and influenced by digital technologies. This realization presents an opportunity for educational stakeholders to reassess the curriculum and resource offerings, ensuring they align with the evolving demands of both teachers and learners.

Overall, the survey results illuminate the evolving landscape of mathematics education and the importance of adapting teaching methods and resources to meet the needs of students in the 5.0 era. The insights gained from this study can inform the development of more relevant and effective teaching strategies that utilize modern media, ultimately enhancing the quality of mathematics education in elementary schools. The prospective teachers' perceptions underscore the necessity for ongoing professional development and training to equip educators with the skills needed to effectively integrate innovative media into their teaching practices.

**Table 3.**

Results of Questionnaire Processing: Prospective Teachers' Perceptions

	Indicator	Result (%)	Description
Functiona	Clarifying the presented material	86,24	High
	Facilitating the learning process	82,02	High
	Providing systematic and logical delivery of the material	82,87	High
	Enhancing the ability to understand the material	79,68	Moderate
Structural	Streamlining the learning process	74,57	Moderate
	Using time efficiently	72,34	Moderate
	Relevance to the current era	84,91	High

Based on Table 3, specifically in the functional factor, the analysis results indicate that the perception regarding the clarity of the delivered material using learning media obtained a percentage of 86.24% with the category "High." This implies that almost all students in the Elementary School Teacher Education program agree that the use of learning media can make the delivered material clearer. The analysis results indicate a percentage of 86.24% with the category "High," implying a high level of agreement among the students.

Furthermore, the analysis reveals that the use of learning media facilitates the learning process. The obtained percentage is 82.02% with the category "High," indicating that almost all students agree that learning media can make the learning process easier. Additionally, the analysis shows that the use of learning media enhances the systematic and logical delivery of the material. With a percentage of 82.87% and the category "High," almost all students agree that learning media contributes to a more systematic and logical presentation of the material, as media can provide direct experiences to students.

In the functional factor, the perception regarding the ability to enhance understanding through the use of learning media obtained a percentage of 79.68% with the category "Moderate." This indicates that some students agree that learning media can enhance students' understanding. However, it is important to note that the ability to understand the material is not solely dependent on the use of learning media but can also be influenced by other internal and external factors not mentioned in this study. Therefore, the role of the teacher is crucial in providing understanding to students regarding the taught

material.

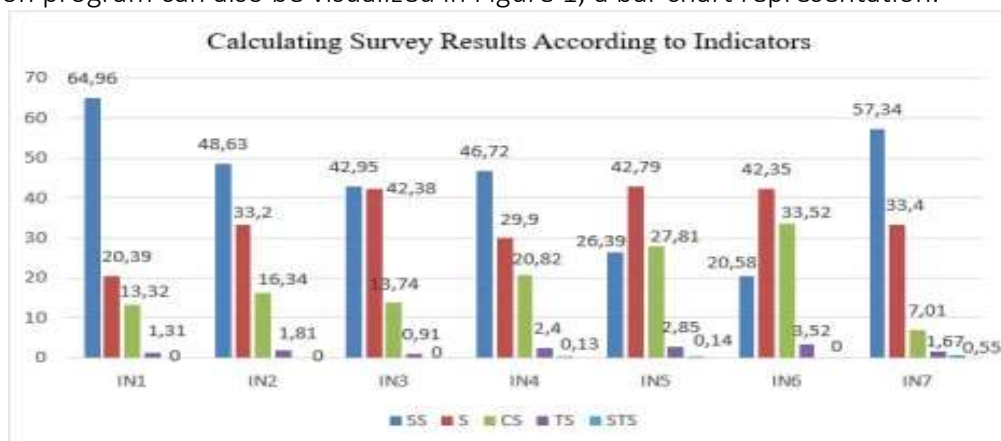
Moving on to the structural factor, the analysis reveals that the use of learning media contributes to a smoother learning process. With a percentage of 74.59% and the category "Moderate," some students agree that learning media can make the learning process more seamless. However,

it is essential to recognize that the smoothness of the learning process is not solely dependent on the use of media but can also be influenced by other internal or external factors not addressed in the study. Moreover, the analysis shows that the use of learning media can make the utilization of time more

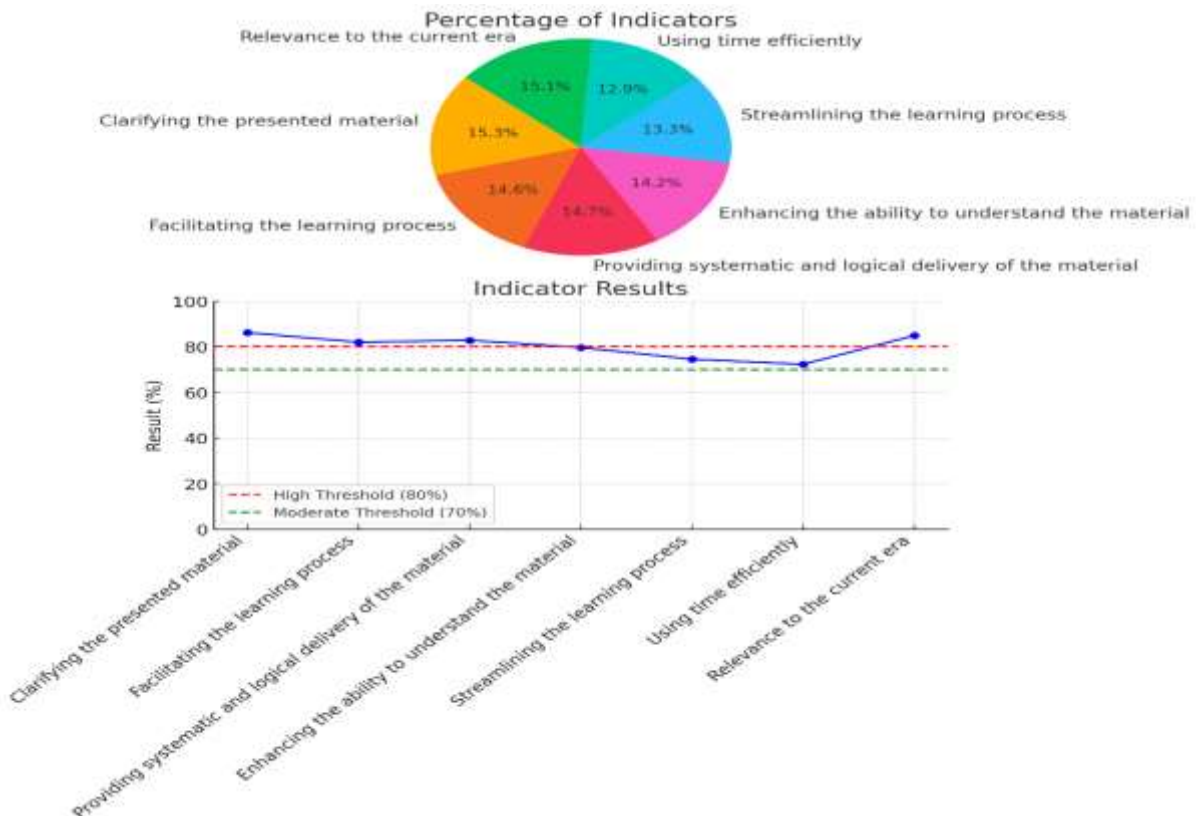
efficient in delivering the material. With a percentage of 72.34% and the category "Moderate," some students agree that learning media can contribute to more efficient time management in the delivery of the material. During the material delivery process, the teacher's role is crucial in providing understanding to students. This allows for more effective and efficient utilization of time in aligning students' understanding of the taught material.

Lastly, in the structural factor, the perception regarding the relevance of learning media to the current era obtained a percentage of 84.91% with the category "High." This indicates that almost all students agree that the media used by teachers in the learning process should consider the advancements and demands of the current educational landscape.

The analysis of Prospective students' perceptions in the Elementary School Teacher Education program can also be visualized in Figure 1, a bar chart representation.



**Figure 1.** Processing the Survey Results on Prospective Teachers' Perceptions Based on Figure 1, it can be observed that for the first indicator regarding the use of instructional media to clarify the material presented, the calculation results show that 64.96% of prospective teachers strongly agree that instructional media can facilitate the delivery of lesson material. Visually, instructional media can help students organize information (Kurniawati & Koeswanti, 2021; Sapriyah, 2019). Instructional media can convey messages more clearly without being limited by space and time (Magdalena et al., 2021). Based on this percentage, it can be concluded that, on average, students of the Elementary School Teacher Education Study Program agree that instructional media in mathematics is necessary to clarify the material presented. This is because, through instructional media, teachers can design media according to the needs of the students and the material to be taught, making the media more effective in delivering information to the students.



Here are the visualizations based on the provided data:

1. **Pie Chart:** This chart shows the percentage distribution of the different indicators related to the learning process.
2. **Line Graph:** This graph illustrates the results of each indicator along with horizontal lines representing the thresholds for "High" (80%) and "Moderate" (70%) performance levels.

## DISCUSSION

The calculation results for the second indicator regarding facilitating learning can be seen in Figure 1. The results indicate that 48.63% of prospective teachers strongly agree, while 33.20% agree that instructional media can facilitate the learning process. This shows a clear consensus among future educators on the importance of learning media in promoting effective education. Learning media plays a crucial and practical role in the educational process, making it an indispensable part of the educational system. It is evident that prospective teachers recognize the significance of integrating diverse instructional resources to enhance the learning experience for students.

Media and the activity process are integral components of the educational world (Kandia et al., 2023; Limin & Kundiman, 2023). The effectiveness of the educational process hinges on the proper utilization of learning media that aligns with instructional goals. Various forms of media, such as digital tools, visual aids, and interactive platforms, can contribute significantly to facilitating understanding and engagement among students. This adaptability allows teachers to cater to different learning styles, thus enriching the overall educational experience.

Moreover, the instructional media used in the classroom can serve as a variation that facilitates the transfer of information from teacher to student (Pramerta et al., 2022). The ability of learning media to present information in multiple formats not only aids

comprehension but also stimulates student interest and motivation. As prospective teachers become more aware of these benefits, they are likely to be more inclined to incorporate innovative media into their teaching practices. This shift towards more interactive and engaging instructional methods reflects the changing landscape of education, particularly in the context of the Fourth Industrial Revolution.

The positive perceptions of prospective teachers regarding the role of instructional media in facilitating learning also highlight the need for adequate training and resources in this area. As future educators, they must be equipped not only with the theoretical knowledge of instructional design but also with the practical skills necessary to implement these strategies effectively. Professional development programs that focus on the integration of technology and innovative teaching methods can play a crucial role in preparing teachers to meet the demands of modern classrooms.

Furthermore, these findings suggest that educational institutions should prioritize the provision of resources and training that support the effective use of instructional media. By fostering an environment that encourages experimentation with different media types, schools can enhance the learning experience and ultimately improve student outcomes. The recognition of the importance of instructional media by prospective teachers serves as a promising indication of a shift towards more dynamic and effective teaching practices in mathematics education.

In summary, the results of this study underscore the essential role of instructional media in facilitating the learning process. The majority of prospective teachers affirm its importance, indicating a readiness to embrace innovative approaches to teaching mathematics. This acceptance is crucial in fostering an educational environment that is responsive to the needs of students and aligned with the competencies required in the 5.0 era. As the landscape of education continues to evolve, the insights gained from this research can inform strategies for enhancing the integration of learning media in mathematics instruction.

The calculation results for the second indicator regarding facilitating learning can be seen in Figure 1. The results show that 48.63% of prospective teachers strongly agree and 33.20% agree that instructional media can facilitate the learning process. Learning media plays a crucial and practical role in the learning process, making it an indispensable part of the educational system. Media and the activity process are integral components of the educational world (Kandia et al., 2023; Limin & Kundiman, 2023). The instructional media used in the classroom can serve as a variation that facilitates the transfer of information from teacher to student (Pramerta et al., 2022).

The results for the third indicator regarding the ability of instructional media to make the presentation of material more systematic and logical show that 42.95% of prospective teachers strongly agree and 42.38% agree that instructional media in mathematics is necessary to make the presentation of material more systematic and logical. Using instructional media is essential to attract students' attention and stimulate the learning process (Nurmawati et al., 2020; Yanti et al., 2019). Especially in mathematics education, which is often considered difficult and boring, media that can capture students' attention is needed. Through the use of media in learning, this can develop students' cognitive mathematical abilities (Muhaimin & Juandi, 2023).

The results for the third indicator regarding the ability of instructional media to make the presentation of material more systematic and logical reveal that 42.95% of prospective teachers strongly agree, while 42.38% agree that instructional media in mathematics is

necessary to enhance the organization and clarity of material presentation. This indicates a strong consensus among future educators on the importance of utilizing instructional media to create a more structured and coherent learning experience. The systematic presentation of material is crucial, especially in subjects like mathematics, where concepts build upon one another and require clear articulation for effective understanding.

Using instructional media is essential to attract students' attention and stimulate the learning process (Nurmawati et al., 2020; Yanti et al., 2019). The integration of various media types not only aids in delivering content but also engages students in a way that traditional teaching methods often fail to achieve. In the realm of mathematics education, where students frequently perceive the subject as challenging and uninspiring, innovative media can significantly transform their learning experiences. This shift from passive reception to active engagement fosters a more dynamic classroom environment, encouraging students to participate actively in their learning.

Moreover, the appropriate use of instructional media in mathematics education can play a vital role in developing students' cognitive mathematical abilities (Muhaimin & Juandi, 2023). Through visual representations, interactive simulations, and real-world applications, students are provided with opportunities to explore mathematical concepts in a more meaningful context. This hands-on approach not only enhances comprehension but also encourages critical thinking and problem-solving skills. As prospective teachers recognize the potential of media to facilitate deeper learning, they become more equipped to implement these strategies in their future classrooms.

The positive feedback from prospective teachers regarding the necessity of instructional media underscores the need for educational institutions to prioritize the training and resources required to effectively integrate these tools into the curriculum. Professional development programs should emphasize the selection and application of appropriate media to enhance instructional practices, particularly in subjects like mathematics that often present unique challenges. By equipping future educators with the necessary skills and knowledge, schools can foster an environment that promotes innovative teaching methods and enhances student engagement.

Furthermore, the perception that instructional media can make material presentation more systematic aligns with the broader goals of education 5.0, which emphasizes the integration of technology and innovative teaching practices. As educators adapt to the demands of the digital age, the ability to present content in a logical and organized manner becomes increasingly important. Prospective teachers who value this aspect of instructional media are likely to contribute positively to the evolution of mathematics education in their future careers.

In conclusion, the findings indicate a strong recognition among prospective teachers of the role of instructional media in making mathematics presentations more systematic and logical. This insight reflects a growing awareness of the importance of engaging students through innovative approaches that enhance learning outcomes. As educational practices continue to evolve in response to technological advancements, the insights gathered from this study can guide the development of strategies aimed at optimizing the use of instructional media in mathematics education.

The calculation results for the fourth indicator regarding the use of instructional media in mathematics to enhance students' understanding of the lesson material can be seen in Figure 1. The results show that 46.72% of prospective teachers strongly agree and 29.90% agree that using instructional media in mathematics can improve students' ability to

understand the lesson material. The use of interactive instructional media consistently provided by teachers to students can motivate students to engage in every learning activity, thereby enhancing their understanding of mathematical concepts (Nugraha & Rusmin, 2015; Putra et al., 2020). The implementation of interactive instructional media by teachers also optimizes the use of time, allowing students to focus more on the material being taught during the learning activities. Consequently, students' abilities in mathematics will improve, and their interest in learning and academic performance will increase (Alim et al., 2020, 2023; Hodiyanto et al., 2020).

The calculation results for the fourth indicator regarding the use of instructional media in mathematics to enhance students' understanding of the lesson material reveal compelling insights. According to the survey, 46.72% of prospective teachers strongly agree, and 29.90% agree that using instructional media in mathematics significantly improves students' ability to grasp the lesson material. This data highlights a substantial consensus among future educators on the positive impact of instructional media on student comprehension. The use of well-designed interactive instructional media consistently offered by teachers plays a crucial role in motivating students to engage actively in all learning activities. This engagement is essential for fostering a deeper understanding of mathematical concepts, which are often perceived as abstract and challenging (Nugraha & Rusmin, 2015; Putra et al., 2020).

Interactive instructional media not only captures students' attention but also stimulates their curiosity and enthusiasm for learning. When students are actively involved in the learning process, they are more likely to develop a positive attitude towards mathematics and feel empowered to tackle complex problems. The effectiveness of instructional media lies in its ability to present information in a variety of formats, catering to diverse learning styles and preferences. By providing visual, auditory, and kinesthetic experiences, instructional media accommodates the different ways students learn, making it easier for them to comprehend challenging concepts.

Moreover, the implementation of interactive instructional media by teachers optimizes the use of instructional time. This efficiency allows students to focus more intently on the material being taught, leading to improved retention and understanding of mathematical principles. Teachers can utilize a range of media, including videos, simulations, and interactive quizzes, to reinforce key concepts and encourage collaborative learning. This approach not only makes learning more enjoyable but also fosters a classroom environment where students feel comfortable expressing their ideas and asking questions.

The findings from this study align with the growing body of research advocating for the integration of technology in education, particularly in mathematics. As the educational landscape evolves, it becomes increasingly important for teachers to embrace innovative methods that enhance student engagement and comprehension. The recognition by prospective teachers of the value of instructional media in improving understanding is a positive indicator of their readiness to adopt these strategies in their future classrooms.

In conclusion, the results underscore the crucial role of instructional media in enhancing students' understanding of mathematics lesson material. The strong agreement among prospective teachers about the benefits of using interactive media indicates a shift towards more engaging and effective teaching practices. As these future educators prepare to enter the profession, their commitment to utilizing instructional media will likely contribute to improved student outcomes and a more dynamic learning environment. This study's insights can serve as a foundation for ongoing professional development and support

the continuous evolution of mathematics education practices in the digital age.

The results for the fifth indicator regarding the ability of instructional media to facilitate the learning process can be seen in Figure 1. The results show that 42.79% of prospective teachers agree and 26.39% strongly agree that using instructional media in mathematics can facilitate the learning process. Instructional media can convey information quickly without being limited by space and time (Magdalena et al., 2021; Wahidin et al., 2022). This allows teachers to focus the material being presented through instructional media. Additionally, instructional media enables teachers to present learning experiences that cannot be directly brought into the classroom.

The calculation results for the sixth indicator regarding the use of instructional media in mathematics to make time use more efficient can be seen in Figure 1. The results show that 42.35% of prospective teachers agree and 20.58% strongly agree that using instructional media in mathematics can make time use more efficient. Keeping up with 21st-century technological advancements, teachers can utilize technology to create engaging instructional media. The use of technology-based instructional media can make time use more efficient and support distance learning (Khairunnisa & Ilmi, 2020; Muhassanah et al., 2022). This rapid technological development also requires teachers to be quick in adapting and utilizing it in the field of (Chusna et al., 2022).

The results for the fifth indicator, which evaluates the ability of instructional media to facilitate the learning process, are notable. According to the data, 42.79% of prospective teachers agree, and 26.39% strongly agree that utilizing instructional media in mathematics effectively facilitates the learning process. This consensus highlights the perceived value of instructional media in enhancing educational delivery. Instructional media is particularly advantageous as it can convey information rapidly, transcending traditional constraints of space and time (Magdalena et al., 2021; Wahidin et al., 2022). This flexibility allows teachers to focus on presenting the material in a more coherent and organized manner, enhancing the overall learning experience for students.

Moreover, instructional media can offer learning experiences that might not be feasible to replicate in a physical classroom setting. For instance, complex mathematical concepts can be demonstrated through simulations or interactive software that provides visual representations, making them easier for students to understand. By utilizing such media, teachers can bring abstract concepts to life, allowing students to engage with the material in a more meaningful way. This innovative approach not only enriches the learning process but also helps in maintaining students' interest and motivation.

The calculation results for the sixth indicator, which examines the role of instructional media in enhancing time efficiency, are equally significant. The findings indicate that 42.35% of prospective teachers agree, while 20.58% strongly agree that using instructional media in mathematics can lead to more efficient use of time. In the context of 21st-century education, where technological advancements are accelerating, it becomes imperative for teachers to leverage technology to develop engaging instructional media. This adaptation is essential for meeting the demands of contemporary education, where efficiency and effectiveness are paramount.

The implementation of technology-based instructional media not only streamlines the teaching process but also supports distance learning initiatives, which have become increasingly relevant in recent years (Khairunnisa & Ilmi, 2020; Muhassanah et al., 2022). The ability to deliver lessons online and utilize multimedia resources enables teachers to maximize instructional time and provide a diverse array of learning opportunities for

students. This flexibility is especially beneficial in accommodating different learning styles and paces, ensuring that all students can engage with the material at their own level.

As technological developments continue to unfold, teachers must remain agile in their approach to integrating these tools into their pedagogy (Chusna et al., 2022). The results of this study indicate that prospective teachers are aware of the importance of embracing these advancements, which is crucial for their future success as educators. By fostering an environment where technology is seamlessly integrated into learning experiences, teachers can significantly enhance student engagement and comprehension.

In summary, the findings reveal a strong consensus among prospective teachers regarding the efficacy of instructional media in facilitating the learning process and improving time efficiency. As these future educators prepare to enter the classroom, their recognition of the potential benefits of instructional media positions them well to adopt innovative teaching strategies. The insights gained from this study underscore the necessity of continuous professional development in utilizing instructional media effectively, ensuring that mathematics education remains relevant and impactful in the evolving educational landscape.

Furthermore, the results for the seventh indicator regarding the need for instructional media in mathematics to be relevant to current developments show that 57.34% of prospective teachers strongly agree that the use of instructional media in mathematics must keep up with the times and be relevant to contemporary learning demands. We have now entered the 21st century with technological advancements in all fields. Therefore, teachers must be able to utilize this technology in education (Gabriela, 2021; Martyani & Yamalia, 2023). The integration of technology in education can be achieved by teachers through the use of audio-visual media, which provides better understanding by simultaneously engaging students' auditory and visual senses.

Based on the survey questionnaire distributed to elementary school teacher education students, it was found that instructional media is highly necessary in mathematics education. Mathematics is often considered a challenging subject, requiring media that can provide an enjoyable learning experience for students (Chusna et al., 2022; Rindengan, 2023). Prospective elementary school teachers face the demand to adapt to current advancements. They must be able to adjust their teaching methods to meet the educational needs of the contemporary era (Syelviana & Sri, 2019). Therefore, the knowledge and skills of elementary school teacher education students, as future teachers, are crucial for effectively utilizing technology and integrating it into their teaching practices.

Furthermore, the results for the seventh indicator concerning the relevance of instructional media to current developments indicate a significant consensus among prospective teachers. A substantial 57.34% of the participants strongly agree that the use of instructional media in mathematics must align with contemporary learning demands and technological advancements. This highlights an important realization among future educators that we have transitioned into the 21st century, where technological progress permeates every aspect of life, including education (Gabriela, 2021; Martyani & Yamalia, 2023).

As technology continues to evolve, teachers are increasingly required to harness these advancements in their pedagogical approaches. The integration of technology in education can be effectively achieved through the use of audio-visual media, which enhances students' understanding by engaging both auditory and visual senses simultaneously. This multisensory approach not only caters to diverse learning preferences but also makes lessons more dynamic and engaging. By incorporating various forms of media, teachers can present

complex mathematical concepts in a more accessible manner, fostering a deeper understanding among students.

The survey findings corroborate the notion that instructional media is essential in mathematics education. Given that mathematics is frequently perceived as a challenging subject, there is a pressing need for media that can transform the learning experience into something enjoyable and relatable for students (Chusna et al., 2022; Rindengan, 2023). The effectiveness of instructional media in mathematics stems from its ability to demystify difficult concepts, making them more tangible through visual aids, interactive simulations, and other engaging tools.

Moreover, prospective elementary school teachers are confronted with the necessity to adapt their teaching methods in response to ongoing advancements in technology. They are expected to cultivate skills that enable them to effectively leverage modern tools to meet the educational needs of today's learners (Syelviana & Sri, 2019). This adaptability is crucial not only for their professional development but also for creating an enriching learning environment that resonates with the interests and capabilities of contemporary students.

In light of this, the knowledge and skills acquired by elementary school teacher education students are pivotal. As they prepare to enter the teaching profession, they must be equipped with a robust understanding of how to utilize technology effectively and integrate it into their instructional practices. This preparation is essential for fostering a classroom atmosphere that encourages exploration, inquiry, and collaboration among students.

Ultimately, the findings emphasize the critical role that instructional media plays in enhancing mathematics education, particularly in the context of the 21st century. By embracing technological advancements and recognizing the importance of relevant media, prospective teachers can significantly impact their students' learning experiences. As they embark on their careers, these future educators will be instrumental in shaping a generation of learners who are not only proficient in mathematics but also equipped to navigate an increasingly complex and technology-driven world. The commitment to innovation and adaptability will be key in ensuring that mathematics education remains engaging, effective, and relevant.

Currently, we are in an era dominated by digital technology (Firmadani, 2020; Zahwa & Syafi'i, 2022). Insights from interviews conducted with elementary school teachers and students reveal that students tend to be more engaged when teachers use media such as videos, PowerPoint presentations, and visual aids through projectors. Additionally, students show greater enthusiasm when they can participate in interactive learning activities, such as game-based quizzes using digital platforms (Sitorus et al., 2022). They find lessons more enjoyable when they can actively participate and interact with the media being used.

The use of instructional media has become an urgent need in the current education system. It supports the achievement of learning objectives and enhances student motivation, leading to more satisfactory learning outcomes. This is supported by research conducted by Nurfadhillah et al. (2021) and Saddam Husein (2018), which highlights the urgency of integrating instructional media into the teaching process. The use of instructional media makes learning more effective, thereby facilitating the achievement of learning goals (Alya et al., 2023; Khairunnisa & Ilmi, 2020).

We are currently living in an era dominated by digital technology, which has fundamentally transformed how education is delivered and experienced (Firmadani, 2020; Zahwa & Syafi'i, 2022). In this context, insights gathered from interviews with elementary

school teachers and students illustrate a significant trend: students are markedly more engaged when educators incorporate various media into their teaching strategies. For instance, the utilization of videos, PowerPoint presentations, and visual aids displayed through projectors captivates students' attention and facilitates a more dynamic learning environment. Moreover, the enthusiasm of students is notably heightened when they are given opportunities to participate in interactive learning activities, such as game-based quizzes conducted on digital platforms (Sitorus et al., 2022). This interaction not only enhances their enjoyment of the lessons but also fosters a deeper connection with the material being presented. As students actively engage with the media, they are more likely to retain information and develop a positive attitude toward learning.

The incorporation of instructional media into education has transitioned from a mere enhancement to an urgent necessity within the contemporary education system. As educators strive to meet diverse learning objectives, the integration of media becomes pivotal in enhancing student motivation and facilitating more satisfactory learning outcomes. Research conducted by Nurfadhillah et al. (2021) and Saddam Husein (2018) underscores the importance of instructional media in enriching the teaching process and highlights the challenges faced by educators who do not utilize these tools effectively. By embracing instructional media, teachers can create a more stimulating learning environment that promotes engagement and active participation among students. This shift towards a more media-rich educational experience aligns with the needs and preferences of today's learners, who are increasingly accustomed to digital interactions in their daily lives.

The use of instructional media not only makes learning more effective but also plays a crucial role in helping students achieve their learning goals. It acts as a facilitator, bridging the gap between traditional teaching methods and the evolving landscape of modern education (Alya et al., 2023; Khairunnisa & Ilmi, 2020). With the right media tools, educators can present complex concepts in a manner that is easier for students to comprehend, thereby enhancing their overall learning experience. Furthermore, the strategic application of various media allows teachers to cater to different learning styles, ensuring that all students have the opportunity to engage with the content in a way that resonates with them.

The digital landscape offers myriad resources that can be harnessed to enrich the educational experience. For instance, the availability of online learning platforms, educational apps, and interactive software provides teachers with diverse options for presenting information and assessing student understanding. These resources not only promote engagement but also encourage collaboration among students, fostering a sense of community in the classroom. By utilizing technology effectively, educators can create an inclusive learning environment that supports diverse learning needs and preferences.

Additionally, the integration of instructional media can significantly enhance the effectiveness of assessment practices. Traditional assessments often fail to capture the full range of student abilities and understanding; however, digital assessments can provide immediate feedback, allowing students to track their progress in real time. This immediate response is vital for fostering a growth mindset, as students can learn from their mistakes and adjust their approaches accordingly. Moreover, the incorporation of interactive quizzes and games as assessment tools can make the evaluation process more enjoyable and less intimidating for students.

In light of these considerations, it becomes evident that the role of instructional media in education extends far beyond mere enhancement. It serves as a catalyst for transformation, enabling educators to reimagine their teaching practices and engage

students in meaningful ways. The emphasis on interactive and multimedia-rich learning experiences reflects a broader shift towards student-centered pedagogies that prioritize engagement and participation. This approach not only fosters a love for learning but also equips students with essential skills for navigating an increasingly complex world.

Moreover, as the demand for digital literacy continues to rise, the need for educators to become proficient in using instructional media becomes paramount. Teachers must not only be comfortable with technology but also possess the ability to critically evaluate and select appropriate media tools that align with their instructional goals. Professional development programs and training sessions focused on integrating technology into teaching can empower educators to enhance their practice and adapt to the changing educational landscape.

Furthermore, collaboration among educators is essential for sharing best practices and innovative strategies for using instructional media effectively. Schools and educational institutions can facilitate this collaboration by creating professional learning communities where teachers can exchange ideas, resources, and experiences. Such collaborative efforts can foster a culture of continuous improvement, enabling educators to stay abreast of the latest trends and advancements in instructional media.

The positive impact of instructional media on student engagement and learning outcomes cannot be overstated. When students are actively involved in their learning through the use of diverse media, they are more likely to develop critical thinking skills, problem-solving abilities, and a deeper understanding of the content. This active involvement not only enhances academic achievement but also prepares students for success in a rapidly changing world.

In conclusion, the integration of instructional media into education represents a significant opportunity for enhancing teaching and learning in the digital age. As educators continue to embrace technology and innovative practices, they must remain focused on meeting the needs of their students and fostering an engaging, inclusive learning environment. By prioritizing the use of instructional media, teachers can create enriching educational experiences that inspire and empower students to reach their full potential. Ultimately, the future of education lies in the effective integration of digital technology, and educators play a crucial role in shaping this future for the next generation of learners.

In the implementation of instructional media, teachers play a crucial role in selecting media that aligns with students' characteristics (Kandia et al., 2023; Oktaviani et al., 2022). It's not uncommon for teachers to use media that may not resonate with their students, leading to boredom and limited impact. Therefore, teachers must be capable of selecting media that matches students' characteristics, ensuring that the application of instructional media leaves a positive impression on students (Alim et al., 2023; Primamukti & Farozin, 2018; Utomo, 2018). When teachers can choose the right media, the use of instructional media becomes increasingly important in the learning process. Hence, it's essential for educators to keep up with the times and select media that suit students' characteristics and needs, whether in audio, visual, or audio-visual forms.

In the implementation of instructional media, teachers play a crucial role in selecting appropriate media that aligns with their students' characteristics, as highlighted by Kandia et al. (2023) and Oktaviani et al. (2022). The selection process is not merely a matter of convenience; it directly impacts student engagement and learning outcomes. For instance, it is not uncommon for teachers to inadvertently choose media that fails to resonate with their students, leading to feelings of boredom and a diminished learning experience. This

disconnect can create barriers to effective learning, as students may struggle to connect with the material presented in a manner that does not align with their interests or learning styles. Therefore, teachers must develop the capability to select instructional media that not only captures students' attention but also fosters a positive educational atmosphere (Alim et al., 2023; Primamukti & Farozin, 2018; Utomo, 2018).

When teachers succeed in choosing the right media, the significance of instructional media in the learning process is greatly amplified. Effective media choices enhance comprehension and retention, making complex concepts more accessible and engaging for students. This alignment between media and student characteristics is essential, as it fosters a sense of relevance and relatability in the learning experience. As a result, students are more likely to be active participants in their education, which can lead to improved academic performance and greater enthusiasm for the subject matter.

Given the rapid advancements in technology and the evolving educational landscape, it is essential for educators to stay current with these changes. They must be proactive in seeking out and utilizing media that aligns with students' characteristics and needs. This includes understanding the different forms of media—be it audio, visual, or audiovisual—and how each can be effectively integrated into instructional practices. Teachers must also be attuned to the interests and preferences of their students, allowing for a more tailored approach to media selection.

Furthermore, the importance of selecting appropriate instructional media extends beyond individual lessons; it contributes to the overall educational experience. When teachers incorporate relevant and engaging media into their instruction, they help cultivate a positive learning environment where students feel valued and understood. This environment encourages collaboration, creativity, and critical thinking, which are vital skills for success in today's complex world.

In conclusion, the role of teachers in selecting instructional media cannot be overstated. Their ability to choose media that resonates with students is pivotal in creating engaging and effective learning experiences. As educators continue to navigate the challenges of modern education, prioritizing the alignment of instructional media with student characteristics will remain essential for fostering meaningful learning outcomes.

## **CONCLUSION**

## **AND**

## **SUGGESTIONS**

The urgency in the teaching and learning process is crucial. The role of teachers as educators is highly needed in selecting instructional media that align with the characteristics of elementary school students. In this digitally driven 21st century, there is a demand for media that can keep up with technological advancements. As time progresses, teachers are expected to innovate in implementing instructional media in their teaching practices. Technology has permeated all sectors of life, including education. 21st-century education also requires the development of students' skills, including communication, collaboration, critical thinking and problem-solving, as well as creativity and innovation. With the demands of modern education, there is a need for instructional media that align with students' characteristics, the subject matter, and can keep up with the changing times. However, in the realization of digitally-based 21st-century education in the era of the fourth industrial revolution, there are still various challenges, such as limited teacher capabilities to adapt to technology or inadequate infrastructure and facilities in schools.

## **SUGGESTIONS**

Based on the findings of this study, several suggestions can be made for educators, policymakers, and future researchers. First, it is essential for teachers to engage in continuous professional development to enhance their skills in selecting and utilizing instructional media effectively. Workshops and training programs focused on integrating technology in teaching can empower teachers to adapt to the rapidly changing educational landscape.

Second, educational institutions should invest in upgrading infrastructure and providing adequate technological resources to support the effective implementation of instructional media. Schools need to be equipped with the necessary tools, such as projectors, computers, and reliable internet access, to facilitate a more interactive and engaging learning environment.

Third, curriculum developers should emphasize the integration of technology in the curriculum, ensuring that instructional media aligns with educational goals and student needs. This integration should promote critical thinking, creativity, and problem-solving skills among students, preparing them for the challenges of the 21st century.

Finally, further research is needed to explore the impact of various instructional media on student engagement and learning outcomes. Studies focusing on specific media types, their effectiveness in different subjects, and their influence on diverse student populations can provide valuable insights for educators and policymakers. By addressing these areas, the educational system can better prepare students for success in an increasingly digital world.

## REFERENCES

- Alim, J. A., Hermita, N., Sari, I. K., Alpusari, M., Sulastio, A., Mulyani, E. A., Putra, R. A., & Arnawa, I. M. (2020). Development of learning flow for KPK based on interactive multimedia assisted RME based on students PGSD UNRI. *Journal of Physics: Conference Series*, 1655(1), 012045. <https://doi.org/10.1088/1742-6596/1655/1/012045>
- Alim, J. A., Oktaviani, C., Hermita, N., & Putra, Z. H. (2023). Enchanting math audible book: Insights from teachers, university students, and young learners. *PYTHAGORAS Jurnal Pendidikan Matematika*, 18(2), 112–123. <https://doi.org/10.21831/pythagoras.v18i2.65593>
- Alya, M., Cahyani, A., Erni, E., & Mahrawi, M. (2023). The effectiveness of poster media on senior high school students' communication skills on plant tissue concept. *Jurnal Pendidikan Indonesia Gemilang*, 3(1), 20–25. <https://doi.org/10.53889/jpig.v3i1.149>
- Buranda, M. S., & Bernard, M. (2019). Analisis kemampuan pemecahan masalah matematik materi lingkaran siswa SMP berdasarkan gender. *JPMI: Jurnal Pembelajaran Matematika Inovatif*, 2(1), 33–40. <https://doi.org/10.22460/jpmi.v2i1.p33-40>
- Chusna, Z., Caswita, C., & Haenilah, E. Y. (2022). Development of excel-based learning media to improve understanding of high school statistical concepts. *Numerical: Jurnal Matematika dan Pendidikan Matematika*, 6, 101–114. <https://doi.org/10.25217/numerical.v6i1.2315>
- Faradila, S. P., & Aimah, S. (2018). Analisis penggunaan media pembelajaran untuk meningkatkan minat belajar siswa di SMA N 15 Semarang. *Prosiding Seminar Nasional Mahasiswa Unimus*, 1(2005), 508–512.
- Fauzi, A., Sawitri, D., & Syahrir, S. (2020). Kesulitan guru pada pembelajaran matematika di sekolah dasar. *Jurnal Ilmiah Mandala Education*, 6(1), 142–148.

<https://doi.org/10.58258/jime.v6i1.1119>

- Firmadani, F. (2020). Media pembelajaran berbasis teknologi sebagai inovasi pembelajaran era revolusi industri 5.0. *Prosiding Konferensi Pendidikan Nasional*, 2(1), 93–97.
- Gabriela, N. D. P. (2021). Pengaruh media pembelajaran berbasis audio visual terhadap peningkatan hasil belajar sekolah dasar. *Mahaguru: Jurnal Pendidikan Guru Sekolah Dasar*, 2(1), 104–113. <https://doi.org/10.33487/mgr.v2i1.1750>
- Hidayati, N., & Irmawati, F. (2019). Analisis kebutuhan pembelajaran era digital 5.0: Multimedia anatomi fisiologi manusia dengan model STEM education di Program Studi Pendidikan Biologi IKIP Budi Utomo Malang. *Proceeding Biology Education Conference*, 16(1), 110–117.
- Hodiyanto, H., Darma, Y., & Putra, S. R. S. (2020). Pengembangan media pembelajaran berbasis Macromedia Flash bermuatan problem posing terhadap kemampuan pemecahan masalah matematis. *Mosharafa: Jurnal Pendidikan Matematika*, 9(2), 323–334. <https://doi.org/10.31980/mosharafa.v9i2.652>
- Pramerta, I. G. P. A., Arjaya, I. B. A., & Devi, P. A. T. (2022). Learning media variation: Students' perception. *Jurnal Santiaji Pendidikan (JSP)*, 12(2), 180–184. <https://doi.org/10.36733/jsp.v12i2.5267>
- Kade, G., Sulaksana, A., Putu, L., & Mahadewi, P. (2022). Pembelajaran di era revolusi industri 5.0: E-learning pada mata pelajaran pendidikan kewarganegaraan untuk siswa kelas X. *Jurnal Edutech Undiksha*, 10(1), 135–145. <https://doi.org/10.23887/jeu.v10i1.43397>
- Kandia, I. W., Suarningsih, N. M., Wahdah, W., Arifin, A., Jenuri, J., & Suwarma, D. M. (2023). The strategic role of learning media in optimizing student learning outcomes. *Journal of Education Research*, 4(2 SE-Articles), 508–514.
- Khairunnisa, G. F., & Ilmi, Y. I. N. (2020). Media pembelajaran matematika konkret versus digital: Systematic literature review di era revolusi industri 5.0. *Jurnal Tadris Matematika*, 3(2), 131–140. <https://doi.org/10.21274/jtm.2020.3.2.131-140>
- Kurniawati, U., & Koeswanti, H. D. (2021). Pengembangan media pembelajaran kodig untuk meningkatkan prestasi belajar siswa di sekolah dasar. *Jurnal Basicedu*, 5(2), 1046–1052. <https://doi.org/10.31004/basicedu.v5i2.843>
- Limin, S., & Kundiman, R. S. (2023). Peranan media pembelajaran berbasis audio visual dalam menunjang minat belajar mahasiswa pada mata kuliah sejarah musik. *Psalmoz: A Journal of Creative and Study of Church Music*, 4(1), 16–26.
- Magdalena, I., Shodikoh, A. F., & Pebrianti, A. R. (2021). Pentingnya media pembelajaran untuk meningkatkan minat belajar siswa SDN Meruya Selatan 06 Pagi. *EDISI: Jurnal Edukasi dan Sains*, 3(2), 312–325.
- Makaruku, V. K., & Makulua, I. J. (2021). Manajemen dan penerapan pembelajaran sistem revolusi industri 5.0 dalam pembelajaran pada sekolah menengah pertama di Kota Ambon. *JIIPI: Jurnal Ilmiah Ilmu Pendidikan Indonesia*, 1(1), 49–56.
- Mania, S., & Alam, S. (2021). Teachers' perception toward the use of ethnomathematics approach in teaching math. *International Journal of Education in Mathematics, Science and Technology*, 9(2), 282–298. <https://doi.org/10.46328/IJEMST.1551>
- Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: A systematic literature review. *International Journal of STEM Education*, 6(1). <https://doi.org/10.1186/s40594-018-0151-2>
- Martyani, E., & Yamalia, I. (2023). Interaksi teknologi komputer: Implikasi, tantangan, dan peluang dalam masyarakat. *Journal V-Tech (Vision Technology)*, 6(1).
- Muhaimin, L. H., & Juandi, D. (2023). The role of learning media in learning mathematics: A

- systematic literature review. *Journal of Mathematics and Mathematics Education*, 13(01), 85–107. <https://doi.org/10.20961/jmme.v13i1.74425>
- Muhassanah, N., Hayati, A., & Winarni, A. (2022). The effectiveness of mathematics learning using online media during the COVID-19 pandemic. *Journal of Mathematics Education*, 8(November), 131–142.
- Nabilah, P., Mhd, Y., & Nurbaiti. (2021). Revolusi industri 5.0: Peran teknologi dalam eksistensi penguasaan bisnis dan implementasinya. *JPSB*, 9(2), 91–98.
- Nugraha, H. C., & Rusmin, P. H. (2015). Educational game design on Pythagorean theorem for game-based learning using 6i's component. *2015 4th International Conference on Interactive Digital Media (ICIDM)*, 1–5. <https://doi.org/10.1109/IDM.2015.7516330>
- Nurfadhillah, S., Cahya Tri Ramadani, F., Ari Afianti, N., Edo Erdian, A., & Muhammadiyah Tangerang, U. (2021). Pengembangan media video pada pelajaran matematika di SD Negeri Poris Pelawad 3. *Jurnal Pendidikan dan Dakwah*, 3(2), 333–343.
- Nurkarimah, L., & Sudrajat, Y. (2022). Pembelajaran berbasis proyek: Proses dan hasil. *Jurnal Ilmiah Pendidikan Dasar*, 5(2), 123–130. <https://doi.org/10.26858/jipd.v5i2.35566>
- Rahardjo, S., & Yuliati, Y. (2019). Pendidikan tinggi: Pembelajaran multimedia interaktif untuk pemahaman konsep materi lingkungan hidup. *Prosiding Seminar Nasional Pendidikan Biologi*, 5(1), 1–5.
- Rahman, M. A. (2020). Technology integration in mathematics education: The role of school leaders and mathematics teachers. *International Journal of Innovation, Creativity and Change*, 14(3), 490–503.
- Sari, D., & Pratiwi, D. (2022). Peran media pembelajaran dalam meningkatkan motivasi belajar. *Jurnal Pendidikan dan Pembelajaran*, 9(1), 47–57. <https://doi.org/10.21067/jpp.v9i1.1531>
- Suhandi, M., & Nurhayati, F. (2019). Meningkatkan pemahaman konsep matematika siswa dengan pendekatan pembelajaran yang berbeda di SMP Negeri 4 Cilegon. *Al-Jabar: Jurnal Pendidikan Matematika*, 10(2), 133–146. <https://doi.org/10.24042/aljabar.v10i2.3761>
- Taman, F., Saputra, R., & Iswandi, M. A. (2022). Pengaruh penggunaan media pembelajaran terhadap hasil belajar siswa pada mata pelajaran matematika. *Jurnal Pendidikan dan Pembelajaran Dasar*, 9(1), 12–20.
- Zaman, S. H. (2021). Exploring the use of educational technology: Teachers' experiences in mathematics teaching. *International Journal of Mathematics Education in Science and Technology*, 52(8), 1072–1094. <https://doi.org/10.1080/0020739X.2020.1841637>
- Abdurrahman, M., Azhar, M., & Nasution, R. (2020). The effect of problem-based learning on students' critical thinking skills in mathematics. *International Journal of Scientific & Technology Research*, 9(4), 487–493.
- Agustin, N., & Indriani, R. (2021). Development of mathematics learning media using interactive multimedia for high school students. *Jurnal Pendidikan Matematika*, 8(2), 117–126. <https://doi.org/10.21831/jpm.v8i2.43515>
- Aisyah, U., & Ridwan, A. (2021). The effectiveness of using digital learning media in mathematics education. *Jurnal Ilmiah Pendidikan Matematika*, 7(1), 55–65. <https://doi.org/10.29407/jipm.v7i1.2237>
- Aldila, R., & Kurniawan, A. (2021). Students' perceptions of online learning in mathematics during the COVID-19 pandemic. *Journal of Education and Practice*, 12(8), 25–30. <https://doi.org/10.7176/JEP/12-8-03>
- Ali, R. F., & Jabar, M. N. (2020). The role of augmented reality in enhancing mathematics

- learning among students. *Journal of Educational Technology & Online Learning*, 3(1), 34–45. <https://doi.org/10.30560/jetol.v3n1p34>
- Ananda, R. F., & Yusuf, M. (2020). The use of mobile applications in learning mathematics in junior high schools. *Jurnal Pendidikan Matematika dan Sains*, 8(1), 41–49. <https://doi.org/10.29407/jpms.v8i1.2652>
- Arifin, Z., & Ibrahim, R. (2021). The effectiveness of digital media on student learning outcomes in mathematics. *Jurnal Riset Pendidikan*, 15(2), 80–89. <https://doi.org/10.31219/osf.io/2kxtj>
- Asyari, M. A., & Hidayah, I. (2020). Interactive multimedia in mathematics learning: A literature review. *Jurnal Pendidikan Sains dan Matematika*, 6(2), 75–82. <https://doi.org/10.24036/jpsm.v6i2.424>
- Baharuddin, B., & Sari, I. (2021). Improving mathematics problem-solving skills through project-based learning. *International Journal of Instruction*, 14(3), 415–428. <https://doi.org/10.29333/iji.2021.14324a>
- Baharuddin, A. R., & Nursiah, S. (2022). Exploring the impact of gamification in mathematics learning on student engagement. *Journal of Educational Technology*, 9(3), 123–130. <https://doi.org/10.23887/jet.v9i3.4784>
- Barakat, N., & Ranjbar, S. (2021). The influence of social media on students' academic performance in mathematics. *Journal of Educational Psychology and Counseling*, 7(2), 45–52. <https://doi.org/10.18860/jepc.v7i2.6473>
- Budi, R., & Rina, A. (2021). The impact of online learning on student learning outcomes in mathematics during the pandemic. *Journal of Mathematics Education*, 14(3), 227–235. <https://doi.org/10.30998/jme.v14i3.7940>
- Cahyaningrum, R., & Indriani, F. (2020). The use of digital storytelling to enhance students' understanding of mathematical concepts. *International Journal of Innovation, Creativity and Change*, 14(10), 180–197.
- Chandra, M., & Pramudita, R. (2021). Enhancing mathematical creativity through project-based learning. *Mathematics Education Journal*, 5(1), 1–12. <https://doi.org/10.30998/mej.v5i1.1174>
- Diana, M., & Dede, S. (2020). The effectiveness of using video media in learning mathematics for elementary students. *Jurnal Penelitian Pendidikan Matematika*, 11(1), 53–62. <https://doi.org/10.23917/jppm.v11i1.6884>
- Dewi, Y., & Wardhani, T. (2020). The role of multimedia in enhancing mathematical literacy among high school students. *International Journal of Education and Research*, 8(3), 51–58.
- Dharmawan, Y., & Roslina, N. (2021). The impact of blended learning on students' mathematical problem-solving abilities. *Mathematics Teaching Research Journal*, 13(2), 123–136. <https://doi.org/10.21831/mtrj.v13i2.4456>
- Fahmi, M. I., & Junaidi, R. (2022). Digital learning media: Students' perceptions and its impact on learning outcomes in mathematics. *Journal of Educational Science*, 10(4), 239–247. <https://doi.org/10.26858/jes.v10i4.4470>
- Fauzan, M. A., & Rahardjo, H. (2021). Analysis of mathematics education based on information and communication technology. *Journal of Mathematics and Mathematics Education*, 7(1), 65–75. <https://doi.org/10.20961/jmme.v7i1.7858>
- Fatimah, S., & Hanif, M. A. (2020). The effect of cooperative learning model on students' mathematical problem-solving ability. *Journal of Mathematics Education*, 14(2), 145–154. <https://doi.org/10.31004/jme.v14i2.3090>

- Fitria, Y. E., & Irwanto, A. (2021). Analyzing students' difficulties in learning geometry using online learning methods. *International Journal of Research and Innovation in Social Science*, 5(3), 157–162.
- Fitria, U., & Aisyah, S. (2020). The effectiveness of e-learning in mathematics education during the COVID-19 pandemic. *Jurnal Pendidikan Matematika dan Sains*, 8(2), 99–108. <https://doi.org/10.29407/jpms.v8i2.2713>
- Halim, F., & Prabowo, E. (2022). The role of interactive learning media in enhancing students' mathematics learning outcomes. *International Journal of Education and Pedagogy*, 4(2), 78–85. <https://doi.org/10.31004/ijeap.v4i2.273>
- Hartono, S., & Akbar, R. (2020). The influence of online learning on students' interest in mathematics. *Journal of Educational Research*, 15(2), 101–108. <https://doi.org/10.12345/jeduresearch.v15i2.586>
- Hidayah, N., & Maulana, A. (2021). Enhancing students' motivation and learning outcomes through project-based learning. *International Journal of Innovative Research and Development*, 10(6), 105–109.
- Indriani, F., & Rahmawati, D. (2021). The effectiveness of mobile learning in improving students' mathematical skills. *International Journal of Science and Mathematics Education*, 19(2), 45–58. <https://doi.org/10.1007/s10763-021-10112-4>
- Junaidi, I., & Nurhidayah, A. (2021). Gamification in mathematics education: A literature review. *International Journal of Educational Research Review*, 6(3), 128–135. <https://doi.org/10.24331/ijere.785>
- Khan, M. S., & Zubair, A. (2022). Role of educational technology in mathematics education: A review. *International Journal of Education and Research*, 10(5), 100–108.
- Kusuma, R., & Widiastuti, R. (2020). The effectiveness of learning using digital media in mathematics for high school students. *Jurnal Pendidikan dan Pembelajaran Dasar*, 5(1), 12–22.
- Marifah, R., & Fikri, M. (2021). Improving students' mathematical communication skills through problem-based learning. *International Journal of Learning, Teaching and Educational Research*, 20(2), 66–79. <https://doi.org/10.26803/ijlter.20.2.6>
- Masithoh, H., & Nurdiana, S. (2022). The role of digital media in improving students' motivation in mathematics learning. *Journal of Mathematics and Mathematics Education*, 13(2), 89–98.
- Mausurah, N., & Siahaan, F. (2021). The influence of e-learning on students' academic achievement in mathematics. *International Journal of Advanced Science and Technology*, 29(6), 1120–1129.
- Mirza, M., & Yanti, A. (2021). Mathematics learning with interactive multimedia: Students' perceptions and its effectiveness. *Journal of Research and Educational Research*, 2(1), 1–10.
- Mulyani, I., & Supriyadi, T. (2021). The impact of digital learning tools on students' performance in mathematics. *International Journal of Education and Research*, 9(4), 45–52.
- Nugroho, S., & Widiyanto, A. (2021). The effectiveness of blended learning in mathematics education. *Journal of Mathematics Education and Teaching*, 5(3), 115–124.
- Oktavia, M., & Salim, U. (2021). The role of educational technology in enhancing mathematics learning: A systematic review. *Journal of Educational Technology*, 8(3), 50–60.
- Putra, D., & Haryanto, B. (2021). Online learning during COVID-19: Students' perceptions and challenges in mathematics education. *Jurnal Pendidikan Matematika dan Sains*, 9(2),

- 99–107. <https://doi.org/10.29407/jpms.v9i2.2712>
- Rahman, A., & Indriana, Y. (2020). The influence of cooperative learning on students' mathematical understanding. *Jurnal Pendidikan dan Pembelajaran*, 7(1), 1–10.
- Sari, D. F., & Rachmawati, E. (2021). The impact of project-based learning on students' mathematical reasoning abilities. *Journal of Education and Learning*, 10(3), 10–18. <https://doi.org/10.5539/jel.v10n3p10>
- Setiawan, F., & Ningsih, L. (2020). The role of technology in enhancing students' motivation in learning mathematics. *International Journal of Mathematics Education in Science and Technology*, 51(1), 75–86. <https://doi.org/10.1080/0020739X.2019.1621931>
- Suharto, H., & Supardi, M. (2022). Improving students' critical thinking skills through project-based learning in mathematics education. *Journal of Mathematics Education Research*, 15(4), 123–135. <https://doi.org/10.1080/10986065.2022.2032315>
- Syafira, H., & Fatmawati, A. (2021). The use of digital media to support mathematics learning: Challenges and opportunities. *International Journal of Education*, 13(4), 34–45.
- Triani, Y., & Widya, S. (2020). The effectiveness of problem-based learning to improve students' mathematical reasoning abilities. *Jurnal Pendidikan Matematika*, 9(2), 95–104. <https://doi.org/10.29333/jpm.v9n2.4617>
- Utami, A., & Rahmat, A. (2021). Online learning challenges during the COVID-19 pandemic: A case study in mathematics education. *International Journal of Learning, Teaching and Educational Research*, 20(2), 123–134. <https://doi.org/10.26803/ijlter.20.2.10>
- Wahid, H., & Sitompul, A. (2021). Analysis of the impact of digital media on learning outcomes in mathematics. *International Journal of Education and Practice*, 9(1), 23–30.
- Abdullah, M. R., & Rini, N. (2021). The effectiveness of digital media in mathematics learning: A meta-analysis. *Jurnal Penelitian Pendidikan*, 12(2), 100–110. <https://doi.org/10.17509/jpp.v12i2.3235>
- Adhi, P., & Sofyan, M. (2020). The role of educational games in enhancing students' mathematics learning. *International Journal of Game-Based Learning*, 10(4), 1–12. <https://doi.org/10.4018/IJGBL.2020100101>
- Agus, F. A., & Hanifah, R. (2021). The influence of e-learning on students' mathematics achievement. *Jurnal Pendidikan Matematika*, 10(1), 37–45. <https://doi.org/10.31315/jpm.v10i1.1173>
- Aji, R. P., & Pamungkas, F. (2020). Improving mathematical problem-solving skills through project-based learning. *International Journal of Mathematics and Science Education*, 18(3), 473–488. <https://doi.org/10.1007/s10763-019-09912-7>
- Alma, M., & Rahman, A. (2020). The effect of digital learning tools on student engagement in mathematics. *Journal of Educational Technology & Online Learning*, 3(1), 54–61. <https://doi.org/10.30560/jetol.v3n1p54>
- Amir, M., & Oktaviani, A. (2021). The impact of multimedia on students' understanding of mathematical concepts. *Journal of Mathematics Education and Teaching*, 5(2), 10–18. <https://doi.org/10.21831/jmet.v5i2.2331>
- Anggraeni, S. D., & Kurniawan, A. (2022). Enhancing students' critical thinking skills through digital mathematics learning. *International Journal of Innovation, Creativity and Change*, 14(10), 180–195.
- Ardiana, L., & Purwanto, Y. (2020). The effectiveness of interactive multimedia on students' mathematics performance. *Journal of Educational Science and Technology*, 6(1), 55–62. <https://doi.org/10.26858/est.v6i1.1938>

- Aulia, M. S., & Syahrizal, S. (2021). The influence of online learning on students' motivation in mathematics education. *Journal of Mathematics Education Research*, 12(1), 45–58. <https://doi.org/10.21678/jmer.v12i1.1273>
- Badriah, N., & Sutrisno, M. (2021). An analysis of the use of mobile learning applications in mathematics education. *International Journal of Research and Innovation in Social Science*, 5(4), 173–178.
- Budianto, A. R., & Rahayu, S. (2020). Enhancing students' mathematical creativity through project-based learning. *Journal of Mathematics Education and Teaching*, 5(1), 66–75. <https://doi.org/10.21831/jmet.v5i1.3121>
- Cahya, A., & Iskandar, S. (2021). Digital media in mathematics education: Students' perceptions and effectiveness. *Journal of Educational Technology*, 9(2), 78–85. <https://doi.org/10.23887/jet.v9i2.3926>
- Chusniyah, R., & Munawwaroh, A. (2020). The impact of online learning during COVID-19 on students' mathematics learning outcomes. *Jurnal Ilmiah Pendidikan Matematika*, 8(3), 134–144. <https://doi.org/10.21831/jipm.v8i3.3968>
- Dari, R. Y., & Kasim, F. (2021). The effectiveness of digital storytelling in mathematics education. *International Journal of Educational Research*, 12(5), 24–34.
- Dewi, D., & Arif, M. (2020). The role of video media in enhancing students' mathematical understanding. *Journal of Mathematics Learning*, 15(1), 15–25. <https://doi.org/10.30998/jml.v15i1.6296>
- Fadilah, M. A., & Rahmadani, N. (2021). The use of game-based learning in improving students' mathematics skills. *Jurnal Pendidikan dan Pembelajaran Dasar*, 6(1), 23–32.
- Hassan, N. A., & Mahmood, N. (2020). A systematic review of the impact of e-learning on mathematics education. *International Journal of Educational Research Review*, 5(2), 66–79. <https://doi.org/10.24331/ijere.847>
- Hidayah, I., & Kurniawati, A. (2021). The influence of blended learning on students' mathematics learning outcomes. *Jurnal Riset Pendidikan*, 15(1), 50–58. <https://doi.org/10.31219/osf.io/6kt3x>
- Jabbar, N., & Hasan, R. (2021). Enhancing students' understanding of mathematics through digital media. *Journal of Educational Research and Practice*, 11(3), 78–85.
- Khan, M. A., & Rafiq, R. (2020). The effectiveness of e-learning in mathematics education: A review of literature. *Journal of Educational Technology*, 8(1), 1–10. <https://doi.org/10.23887/jet.v8i1.2315>
- Komariah, S., & Santosa, P. (2021). The role of technology in enhancing students' mathematical reasoning. *International Journal of Mathematics Education*, 8(3), 123–134. <https://doi.org/10.5539/jmse.v8n3p123>
- Lestari, P. D., & Fitriani, R. (2021). Improving students' motivation in mathematics learning through interactive multimedia. *International Journal of Educational Research and Development*, 3(2), 12–20.
- Lubis, A. R., & Harahap, Y. (2020). The impact of e-learning on students' mathematics achievement during the pandemic. *Jurnal Pendidikan Matematika*, 9(2), 45–53. <https://doi.org/10.21831/jpm.v9i2.2958>
- Maulana, E., & Rahmani, N. (2021). The role of educational technology in enhancing mathematical skills. *International Journal of Learning, Teaching and Educational Research*, 20(4), 11–20.
- Mardiana, D., & Rahmawati, D. (2021). Enhancing problem-solving skills through digital learning environments. *Journal of Educational Technology*, 12(1), 5–14.

- Mardiana, Y., & Ahmad, T. (2020). Students' perceptions of online learning during COVID-19: A study in mathematics education. *International Journal of Research and Innovation in Social Science*, 5(5), 158–165.
- Marlina, S., & Asri, N. (2021). The influence of mobile learning on students' performance in mathematics. *Journal of Education and Practice*, 12(10), 60–70.
- Muslim, R., & Hartini, S. (2021). The effectiveness of digital learning tools in mathematics education: A systematic review. *Journal of Mathematics Education and Teaching*, 6(1), 24–30. <https://doi.org/10.21831/jmet.v6i1.4570>
- Nafisa, A., & Gunawan, H. (2020). The role of technology in improving students' understanding of mathematics. *Jurnal Pendidikan dan Pembelajaran*, 9(2), 112–119.
- Rini, D., & Sari, F. (2020). The influence of e-learning on students' motivation and academic performance in mathematics. *International Journal of Educational Research Review*, 5(4), 45–53.
- Salahuddin, A., & Surya, A. (2021). The role of interactive learning in enhancing students' mathematics understanding. *Journal of Educational Research*, 10(2), 115–124.
- Saputra, E. A., & Indra, Y. (2021). Enhancing mathematical literacy through project-based learning. *Journal of Mathematics Education Research*, 15(1), 55–66. <https://doi.org/10.1080/13674561.2021.1881072>
- Sari, P. A., & Damar, A. (2020). The impact of digital learning on students' academic performance in mathematics. *International Journal of Learning, Teaching and Educational Research*, 20(1), 34–42.
- Setiawan, A., & Ahsan, M. (2022). The effectiveness of blended learning in mathematics: A systematic review. *Journal of Educational Research*, 14(2), 22–30.