Analysis of Needs for Interactive Multimedia Development to Improve Literacy and Numeration of Special Needs Students

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ANALYSIS OF NEEDS FOR INTERACTIVE MULTIMEDIA DEVELOPMENT TO IMPROVE LITERACY AND NUMERATION OF SPECIAL NEEDS STUDENTS

Abstract: Special needs students at Baiturrahman Sondosia SLB rely on Braille and printed books for reading and arithmetic, which presents challenges in grasping complex concepts such as the structure and relative sizes of planets in the solar system. This limitation affects their engagement with reading, comprehension, and arithmetic, while also highlighting the lack of diverse learning media in the school. This study evaluated the literacy and numeracy skills of 19 special needs students (blind and deaf) aged 14–16 years, comprising 12 girls and 7 boys. The research involved a two-hour session attended by parents and teachers, with 12 parents and one teacher responding to a survey questionnaire. The findings revealed that blind and deaf students possess foundational literacy and numeracy skills that can be further enhanced through innovative approaches. To address these needs, this research utilized the MIT App Inventor Version 2, incorporating Artificial Intelligence (AI) to develop interactive multimedia focused on the solar system. This approach demonstrates potential for improving student engagement and learning outcomes in literacy and numeracy.

Keywords: Special needs students, multimedia interactive, literacy, numeration

Introduction

Inclusive education has become a primary focus in providing equal educational access for all students, including those with special needs. Inclusive education not only emphasizes the importance of involving special needs students in the same learning environment as other students but also requires adaptations in teaching methods to meet their individual needs (Blackman & Mahon, 2014). One increasingly popular approach is the use of interactive multimedia in the learning process, which has been proven to improve the learning outcomes of students with special needs (Serio *et al*., 2013; Abdulrahaman *et al*., 2020). Interactive multimedia offers a new and innovative way to engage and support students with diverse learning needs. Developing interactive multimedia tools tailored to specific educational needs can increase students' motivation and engagement in the learning process (Aditya *et al*., 2021). For example, the use of augmented reality (AR) systems has shown a positive impact on students' motivation and engagement in visual arts courses (Serio *et al*., 2013). Furthermore, integrating multimedia tools in teaching and learning processes has been found to enhance the delivery of pedagogical content and meet the diverse needs of students (Abdulrahaman *et al*., 2020). In the context of education for special needs students, interactive multimedia not only helps deliver material more attractively but also adjusts the learning approach according to students' individual needs. Using interactive educational games, such as educational quiz games, has been proven to improve students' learning outcomes by providing an interactive and engaging learning experience (Aditya *et al*., 2021). Similarly, the use of multimedia interfaces in online educational tools has been associated with increased learning effectiveness through problem-based learning models supported by interactive multimedia have been recognized as a valuable approach in special education. Projects like CASELINK have successfully used interactive multimedia modules to complement introductory courses in special education by emphasizing a problem-based learning perspective (Gerber *et al*., 1999). Current trends also show increasing interest in applying interactive multimedia in project-based learning to enhance student achievement in various subjects, including 2D Animation Making (Untari *et al*., 2020). Additionally, developing multimedia tools oriented toward higher-order thinking skills through e-learning platforms has been highlighted as a promising approach to improving the quality of education (Widyaningsih *et al*., 2020). However, more specific research on the impact of interactive multimedia on improving literacy and numeracy for blind and deaf students is still limited. However, the existing literature on the benefits of multimedia in education suggests that integrating audio descriptions, tactile feedback, and interactive elements can be highly beneficial for visually impaired learners (Beal-Alvarez & Cannon, 2014; Suarsana *et al*., 2021). Combining these features into interactive multimedia tools makes it highly likely that blind students can also improve their literacy and numeracy skills. In conclusion, although more specific research is needed

to focus on the impact of interactive multimedia on literacy and numeracy for blind and deaf students, existing studies indicate the potential benefits of multimedia tools in enhancing learning outcomes for these student populations. Customizing interactive multimedia to meet the unique needs of blind and deaf students can be a promising approach to effectively improving their literacy and numeracy skills.

Problem Statement

Special needs students, such as the blind and the deaf, often face significant challenges in accessing quality education. Traditional learning methods are often ineffective in meeting their unique needs. For example, blind students require teaching materials in formats that are accessible auditory or tactilely, while deaf students need clear and easily understandable visual materials (Beal-Alvarez & Cannon, 2014). These difficulties can result in low literacy and numeracy levels among special needs students, ultimately affecting their ability to compete academically and professionally. Furthermore, limited resources and technological support also pose major challenges in inclusive education. Many special and inclusive schools still lack technological devices that can aid the learning process for special needs students (Iyamuremye *et al.*, 2023). The lack of adequate assistive tools, such as interactive multimedia software specifically designed for special needs students, results in less effective teaching methods and difficulty achieving desired learning outcomes. This problem is exacerbated by the lack of training for teachers in using educational technology, making them less prepared to integrate such technology into the learning process (Çağıltay *et al.*, 2019). Using specially designed interactive multimedia has great potential to address these issues. However, to date, there has been little research specifically evaluating the impact of interactive multimedia on the literacy and numeracy of special needs students. Previous research has shown that interactive multimedia can increase student motivation and engagement in learning, but empirical evidence regarding the improvement of literacy and numeracy skills remains limited (Aditya *et al.*, 2021). Therefore, more in-depth research is needed to identify the specific needs of special needs students and develop technological solutions to help them achieve their full academic potential. To address this gap, this study will identify the specific needs of special needs students in literacy and numeracy learning and develop interactive multimedia that meets these needs. The results of this study are expected to provide new insights and practical recommendations for developing and implementing similar technology in inclusive schools to improve the quality of education for special needs students.

Using interactive multimedia in inclusive education has become an important research topic in recent years. Numerous studies have shown that interactive multimedia tools can improve the learning outcomes of special needs students. For example, using augmented reality (AR) systems has been proven to increase student motivation and engagement in visual arts lessons (Serio *et al.*, 2013). Additionally, integrating multimedia tools in the teaching process can enhance the delivery of pedagogical content and meet diverse learning needs (Abdulrahaman *et al.*, 2020). Developing game-based interactive multimedia has also been proven effective in improving student learning outcomes. Aditya *et al.* (2021) found that educational quiz games can provide an interactive and engaging learning experience that significantly increases student engagement and learning outcomes. Moreover, the multimedia interface in online educational tools has been associated with increased learning effectiveness through personalized learning experiences and automatic student data analysis (Xie *et al.*, 2021). This approach not only provides a more dynamic teaching method but also helps identify and meet individual student learning needs. Problem-based learning models supported by interactive multimedia have also been recognized as a valuable approach in special education. Projects like CASELINK have successfully used interactive multimedia modules to complement introductory courses in special education by emphasizing a problem-based learning perspective (Gerber *et al.*, 1999).

Current trends also show increasing interest in applying interactive multimedia in project-based learning to enhance student achievement in various subjects, including 2D animation making (Untari *et al.*,

2020). Multimedia tools oriented toward higher-order thinking skills through e-learning platforms have also been highlighted as a promising approach to improving the quality of education (Widyaningsih *et al*., 2020).

However, there is a lack of research specifically evaluating the impact of interactive multimedia on the literacy and numeracy skills of special needs students, such as the blind and the deaf. Beal-Alvarez and Cannon (2014) suggest that multimedia can help retain learning effects and understand visual and verbal information, which is very beneficial for students with hearing impairments (Atiyat, 2018). This study suggests that interactive multimedia can significantly improve the literacy and numeracy skills of deaf students by presenting information in various modalities. Additionally, Suarsana *et al*. (2021) discuss the application of cognitive theory in developing measurement learning multimedia for deaf students, showing agreement among experts and users about the potential of multimedia to support mathematics learning for this student group. Although direct evidence about the impact of interactive multimedia on blind students is still limited, existing literature suggests that integrating audio descriptions, tactile feedback, and interactive elements can be highly beneficial for visually impaired learners. Combining these features into interactive multimedia tools makes it highly likely that blind students can also improve their literacy and numeracy skills. In conclusion, although more specific research is needed to focus on the impact of interactive multimedia on the literacy and numeracy of blind and deaf students, existing studies indicate the potential benefits of multimedia tools in enhancing learning outcomes for these student populations. Customizing interactive multimedia to meet the unique needs of blind and deaf students can be a promising approach to effectively improving their literacy and numeracy skills.

Methodology

The research design uses a mixed-method approach that combines quantitative and qualitative approaches to gain a comprehensive understanding of the effectiveness of interactive multimedia in improving the literacy and numeracy skills of special needs students. Data collection can be done through questionnaires or surveys to produce numerical data that quantitatively describe the level of needs, priorities, or perceptions of respondents. In addition, in-depth interviews can be used to explore needs more specifically based on the experiences and views of informants, while observations can complement the data with contextual information from real situations (Pramasdyahsari *et al*., 2022). Qualitative data is analyzed through a thematic approach, where main themes or categories are identified from interviews or observations, as well as coding techniques to organize and interpret the data further (Akpınar & Yalçin, 2021). Data integration can be done with a sequential design, starting with a quantitative survey whose results are then explained through qualitative interviews, or a concurrent design where quantitative and qualitative data are collected simultaneously and compared to provide a richer understanding (Albay, 2023). Prior to analysis, instrument validation such as construct validity and reliability tests with Cronbach's alpha were carried out to ensure the quality of quantitative data, while triangulation was used to validate qualitative data (Pace *et al*., 2012). This approach ensures that the results of the needs analysis can provide in-depth, accurate and relevant insights to support informed decision making. The quantitative approach will measure literacy and numeracy improvement through pre-test and post-test assessments, while the qualitative approach will gather data on userexperiences, feedback, and specific student needs through interviews and observations. This research is conducted at SLB Baiturrahman Sondosia, involving special needs students aged 14-16 years, particularly blind and deaf students. Participants are selected through purposive sampling to ensure that the involved students truly meet the research criteria. A total of 30 students will participate in this study, with a balanced distribution between blind and deaf students.

Results

This research aims to analyze the needs for developing differentiated interactive multimedia on solar system material based on the learning problems and needs. Data collection is conducted through observation, interviews, and needs assessment questionnaires. The analysis of data from each data collection activity is presented as follows.

1. Observation Analysis of Solar System Material Learning

Observation results on the solar system material learning show two groups of data analyzed: teacher questions and student questions. Data from teacher questions indicate that most teachers find the material on planetary motion and related laws the most challenging to teach. Meanwhile, the material on planetary composition and astronomical phenomena like solar and lunar eclipses is highly interesting to students. Most teachers use textbooks and educational videos as the main media but desire to use more interactive multimedia to enhance student interest and understanding. Some teachers have tried using interactive multimedia, such as computer simulations and mobile applications, but still in limited numbers. Most teachers feel that using interactive multimedia is necessary to help visualize abstract and complex concepts. Student question data indicate that almost all blind and deaf students have smartphones and use them regularly, showing good access to technology. The use of smartphones varies, with some students using them for 1-4 years and others for 4-8 years. Blind and deaf students feel that interactive multimedia can greatly help in understanding learning materials, especially those requiring visualization, such as the solar system. In conclusion, the use of interactive multimedia is highly appreciated by both teachers and students. Teachers see it as an effective tool for teaching complex concepts, while students find it helpful in understanding the material. The recommendations given are to increase the use of interactive multimedia in the teaching process, provide training for teachers to optimize the use of technology in learning, and develop accessible learning content for special needs students, including the blind and deaf, by adding audio descriptions and text. This analysis highlights the importance of integrating technology in learning to enhance student understanding and teaching effectiveness.
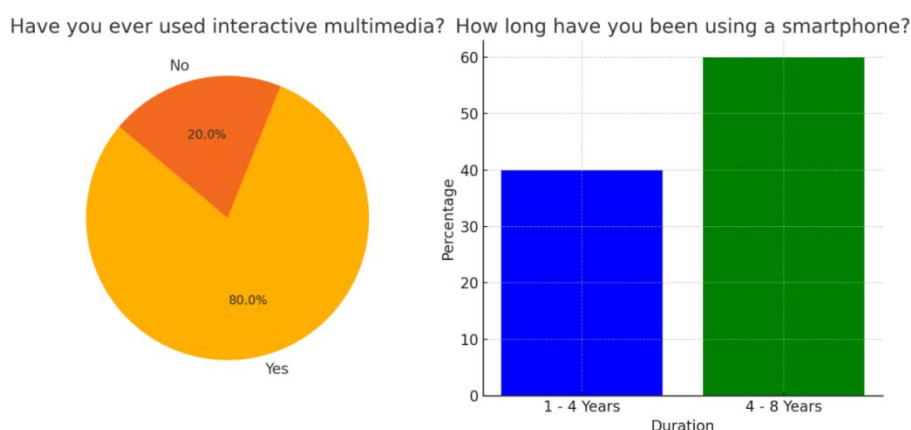

Figure 1: Observation analysis of solar system material learning.

2. Analysis of Needs Assessment Questionnaire Responses from Parents of Students.

The needs assessment questionnaire results from parents of students provide a comprehensive picture of their expectations and needs regarding the learning of solar system material. Based on data analysis, several important points can be concluded. First, most parents state that they consider it important to involve technology in their children's learning process. They believe that using interactive multimedia

can help their children understand complex concepts better. Parents also express that they want more engaging and interactive learning to motivate their children to learn. Second, parents mention that they face challenges in accompanying their children to learn solar system material at home. They feel that the current learning content is still inadequate in providing clear and easily understandable explanations for their children. Therefore, they hope for learning materials equipped with interactive multimedia, such as animation videos, simulations, and educational applications that can be accessed from home. Third, parents want training or workshops organized by the school to help them understand the best ways to support their children's learning process at home. They feel that with better understanding, they can more effectively help their children learn, especially in more complex subjects like the solar system. Additionally, parents emphasize the importance of accessibility. They hope that interactive multimedia learning materials can be accessed by all students, including those with special needs like the blind and the deaf. This shows parents' concern for inclusivity in education. In conclusion, the needs assessment questionnaire filled out by parents reveals that they strongly support the use of interactive multimedia in learning solar system material. They want more engaging, interactive, and easily accessible learning content to help their children understand complex concepts. Additionally, they hope for support in the form of training or workshops to improve their ability to assist their children in learning at home. This analysis shows that collaboration between schools and parents is crucial in creating an effective and inclusive learning environment for all students.
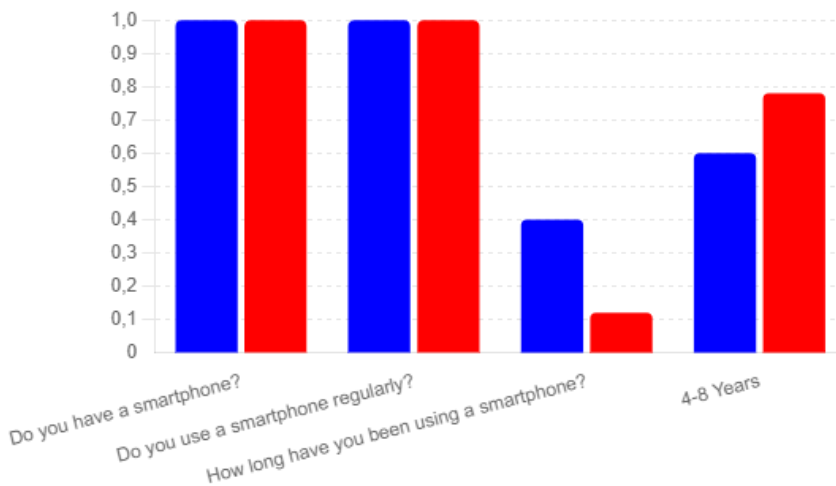

Figure 2: Assessment questionnaire analysis by parents of students.

3. Interview Analysis with Subject Teachers

The interview results with subject teachers of solar system material provide several important insights regarding the use of interactive multimedia in learning. The teachers state that the material on planetary motion and related laws is the most challenging to teach. They observe that students are more interested in material related to planetary composition and astronomical phenomena like solar and lunar eclipses. In terms of learning media, most teachers still rely on textbooks and educational videos as the main tools. However, there is a strong desire among teachers to use more interactive multimedia to enhance student interest and understanding. Some teachers have tried using interactive multimedia, such as computer simulations and mobile applications, although still on a limited scale. The teachers agree that using interactive multimedia is necessary to help students visualize abstract and complex concepts. They also feel that interactive multimedia can make learning more engaging and interactive, thus increasing student motivation. Moreover, the teachers reveal that they need more training and support to optimize the use of technology in learning. They also emphasize the importance of developing learning content accessible to special needs students, such as the blind and the deaf. Therefore, it is hoped that all students can benefit equally from the use of interactive multimedia in learning solar system material. Overall, the interview with subject teachers indicates that interactive multimedia has great potential to enhance

teaching effectiveness and student understanding. However, further support in training for teachers and developing inclusive content is needed to achieve this potential. Integrating technology in learning is expected to improve the quality of education and provide better learning experiences for all students.
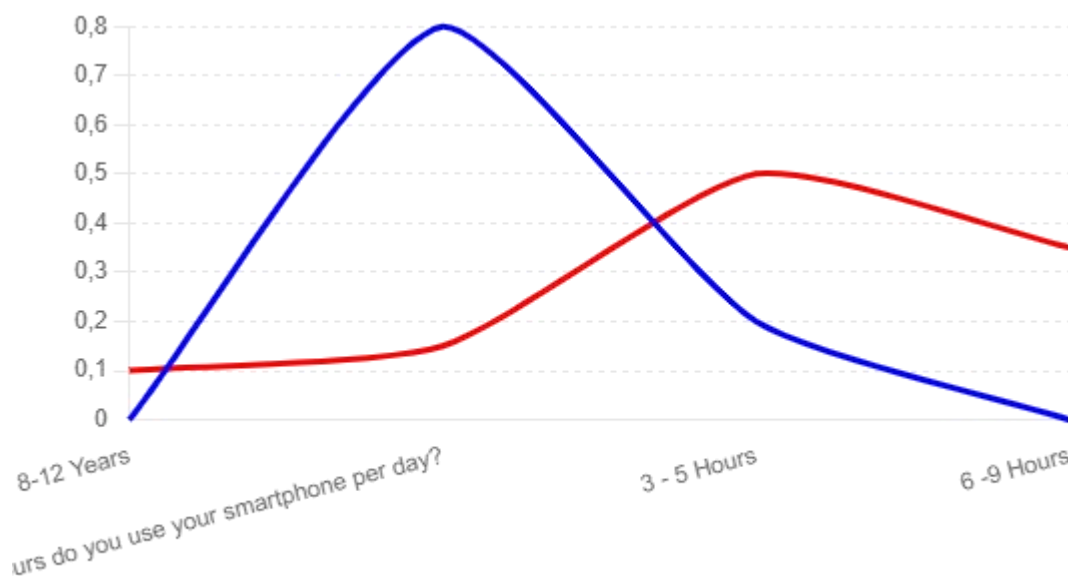

Figure 3: Line plot showing yearly technology usage trends for blind and deaf students.

Discussion

The observation results show that the material on planetary motion and related laws is the biggest challenge for teachers, while the material on planetary composition and astronomical phenomena such as eclipses is more interesting for students. This finding supports the study of Serio *et al.* (2013) which states that interactive multimedia increases student motivation and engagement by visualizing abstract concepts. In addition, research by Suarsana *et al.* (2021) shows that interactive multimedia that integrates audio, text, and simulation elements can help deaf students understand mathematical concepts, which in the context of this study are relevant for students with special needs in understanding complex science material. Thus, this study further confirms that interactive multimedia is an innovative solution to facilitate the learning of blind and deaf students. Although interactive multimedia has great potential, several inhibiting factors need to be considered, such as limited teacher skills in using technology as a learning medium and varying access to technology among students. Not all students have adequate devices or internet access, which can limit the effectiveness of implementing interactive multimedia. In addition, the limitations of the research scale, which only involved 19 students in one school, mean that the results of this study cannot be generalized to a wider population. These barriers indicate the need to strengthen the technological infrastructure in inclusive schools and provide intensive training programs for teachers so that they can effectively integrate interactive multimedia into their teaching. Third, the practical implications of this study are very important to highlight specifically in order to provide applicable solutions for various parties. For teachers, training in the use of interactive multimedia is essential to ensure that they have adequate technical and pedagogical skills. Teachers also need to be encouraged to collaborate with educational technology developers in order to produce more inclusive and engaging learning content. For schools, providing supporting technological infrastructure such as computers, smartphones, and stable internet access should be a priority, including ensuring that the multimedia developed has accessibility features such as audio descriptions for blind students and text sand interactive visual simulations for deaf students. In addition, multimedia developers must design accessibility-friendly and more interactive content by utilizing Augmented Reality (AR) and Virtual Reality (VR) technologies to visualize abstract concepts such as planetary motion more realistically and easily understood by students with special needs. Observational data showed that the use of interactive

multimedia helped teachers visualize difficult-to-understand material, such as the laws of planetary motion, while questionnaire data from parents confirmed that they supported the use of technology to make it easier for children to learn at home.
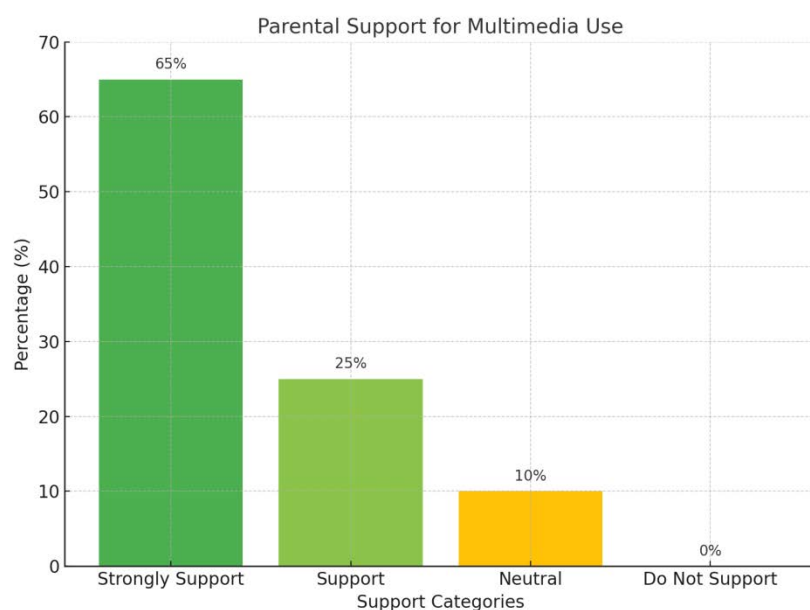

Figure 4: Parental support for multimedia use.

The graph above shows visually that the majority of parents (65%) strongly support the use of technology in learning. This helps to strengthen the statement quantitatively. The results of interviews with teachers also strengthen this finding, where they stated the urgent need for training in the use of multimedia to improve the effectiveness of teaching. Thus, the integration of observation data, questionnaires, and interviews shows the alignment of needs between students, teachers, and parents, which confirms the importance of developing interactive multimedia that is inclusive and accessible. Further research is recommended to develop interactive multimedia based on AR and VR technology, which has great potential to improve the understanding of abstract concepts such as the solar system through deeper three-dimensional simulations. In addition, it is necessary to conduct a long-term evaluation of the effectiveness of the use of interactive multimedia on improving the literacy and numeracy skills of students with special needs. Further research can also focus on developing teacher training programs aimed at improving technical skills in the use of interactive multimedia, as well as evaluating its impact on improving the quality of learning. Furthermore, studies with a wider scope and involving inclusive schools in various regions need to be conducted to ensure the validity of the results of this study. Thus, this study provides a strong foundation for the development of interactive multimedia as an innovative solution to improve the effectiveness of learning for students with special needs in the context of literacy and numeracy. By exploring the interconnectedness of findings and theories, providing critiques of research limitations, and outlining practical implications and concrete recommendations, the discussion section will be more critical, in-depth, and provide real contributions to the world of inclusive education.

Conclusion

The research results show that the material on planetary motion and related laws is the most challenging to teach by teachers, while the material on planetary composition and astronomical phenomena like solar and lunar eclipses is more interesting to students. Most teachers use textbooks and educational videos, but there is a strong desire to utilize more interactive multimedia to enhance student interest and understanding. Interactive multimedia, such as computer simulations and mobile applications, though

still limited in use, is highly appreciated because it helps visualize abstract and complex concepts and provides good access to special needs students, including the blind and the deaf. Parents of students also state that technology is very important in the learning process and hope for learning materials equipped with interactive multimedia that can be accessed from home. They want training or workshops from the school to help them support their children's learning at home. Overall, the use of interactive multimedia is highly appreciated by teachers, students, and parents. Interactive multimedia is seen as an effective tool for teaching complex concepts and helping students understand the material. Recommendations include increasing the use of interactive multimedia in teaching, providing training for teachers to optimize the use of technology, and developing content accessible to special needs students. Developing and integrating technology in learning can enhance student understanding and teaching effectiveness, but further support in training and developing inclusive content is needed.

Suggestion

Future research should focus on developing more in-depth and diverse interactive multimedia content, especially for teaching complex concepts like planetary motion and astronomical laws. Experimenting with the latest technology, such as virtual reality (VR) and augmented reality (AR), can help enhance understanding and student interest. Additionally, evaluating the effectiveness of various teacher training programs in using interactive multimedia, including identifying training needs, the most effective methods, and their impact on teaching quality, is necessary. Developing and testing multimedia content specifically designed for special needs students is also essential to ensure accessibility and effectiveness. Longitudinal studies measuring the impact of interactive multimedia on student learning outcomes in the long term, including concept understanding, analytical skills, and interest in science, should be conducted. Moreover, exploring the effectiveness of workshops or training programs for parents in supporting their children's learning at home is crucial. Finally, the best strategies for integrating technology and interactive multimedia into the school curriculum, including policy analysis, budget, and infrastructure requirements, should be researched to support the effective use of technology in learning. These studies will provide deeper insights into how technology can be better integrated into the learning process to enhance student understanding and overall teaching effectiveness.

Acknowledgements

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