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Development of Learning Materials for Social Skills Based on Augmented Reality for People with Autism

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Abstract: Students with Autism Spectrum Disorder (ASD) often experience difficulties in social skills, including empathy, peer interaction, and appropriate social behavior. These challenges require learning media that are engaging, interactive, and compatible with the visual learning characteristics of students with autism. This study aimed to develop Augmented Reality (AR)-based social skills learning materials and examine their validity, practicality, and effectiveness for students with autism. The study employed a Research and Development (R&D) approach using the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. The participants were 10 students with autism enrolled in the lower grades of a special school in Surabaya, Indonesia. Data were collected through expert validation questionnaires, user practicality questionnaires, and pretest-posttest assessments. The developed product is an Android-based AR application containing instructional videos, interactive 3D objects, quizzes, and reinforcement features. Validation results indicated that the media was highly feasible for use in learning. Practicality assessments also showed positive responses from users. Furthermore, the Wilcoxon Signed-Rank Test revealed a significant improvement in students' social skills after using the media ($p < 0.05$). These findings indicate that AR-based learning materials are valid, practical, and effective in supporting the development of social skills among students with autism.

Keywords: *augmented reality, educational media, social skills, autism spectrum disorder*

I. Introduction

Social skills are essential abilities that every individual must possess to build interpersonal relationships, communicate, and adapt to their social environment. However, students with Autism Spectrum Disorder (ASD) often face challenges in these areas. According to recent estimates from the World Health Organization, approximately 1 in 100 children worldwide is diagnosed with Autism Spectrum Disorder (ASD). In Indonesia, the number of children identified with ASD has continued to increase, creating a growing need for appropriate educational interventions and learning support. This condition highlights the importance of developing innovative learning media that can effectively support the social and communication needs of students with autism. According to Attwood (2007), children with autism have difficulty understanding social norms, initiating and maintaining conversations, and interpreting others' facial expressions and body language. This condition limits their ability to interact with their surroundings. Manning et al. (2021) also explain that children with autism often face various challenges with social skills, while Pascoe et al. (2023) state that poor social skills can hinder a child's socialization process with their environment.

Social skills play a crucial role in supporting educational success, friendships, and the independence of children with autism. Yuswatiningsih (2021) explains that barriers to social interaction can affect a child's ability to understand others' feelings, value friends, and control behavior that could potentially harm others. Meanwhile, McConel (2020) emphasizes that social skills are one of the competencies that need to be developed to support the future lives of children with autism. Therefore, learning strategies are needed that can help students with autism understand social concepts concretely and in a way that aligns with their learning characteristics.

One approach that can be taken is the use of engaging learning materials tailored to the characteristics of students with autism. Silva (2024) states that appropriate learning materials can help children with autism visualize content in line with their visual learning style, thereby enhancing their attention and motivation to learn. In line with developments in educational technology, Augmented Reality (AR) has emerged as an innovation with the potential to support the learning process, as it can interactively integrate virtual objects into the real environment. Berenguer et al.

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(2020) revealed that AR technology can improve the social skills of children with autism, particularly in understanding facial expressions and nonverbal communication. Additionally, Radu et al. (2020) found that AR-based systems can help children with autism recognize emotions and strengthen social skills in daily life.

The effectiveness of using AR technology in the education of children with autism is also supported by various previous studies. Miningrum (2021) demonstrated that the augmented reality-based application AREmotion is effective in improving emotional understanding in children with autism. Mar'atullatifah's (2023) study also proves that the use of augmented reality-based learning media can improve the learning outcomes of children with autism, as evidenced by an increase in the average score from 76 to 85.8. Additionally, Kourtesis et al. (2023) report that Virtual Reality-based social skills training provides a significant improvement in the social skills of children with autism. Nevertheless, most of these studies still focus on aspects of emotion recognition or specific academic subjects, so the development of AR media specifically targeting social skills remains limited.

Preliminary observations conducted at Mutiara Hati Autism Education Foundation, Surabaya, revealed that students with autism experienced difficulties in understanding and practicing social skills in daily interactions. Teachers primarily relied on conventional instructional approaches, while students demonstrated greater interest and engagement when learning activities involved digital devices. These findings indicate a need for innovative learning media that can support the development of social skills through interactive and visually engaging learning experiences.

Based on these conditions, this study developed an Augmented Reality-based social skills learning tool on the Android platform designed to improve empathy, foster respect for peers, and reduce harmful behavior toward peers among students with autism. The novelty of this study lies in the development of an Android-based Augmented Reality learning application specifically designed to improve social skills among students with autism. Unlike previous studies that focused on emotion recognition or object identification, the developed application addresses three essential social skill domains: empathy, respecting peers, and preventing aggressive behavior. Furthermore, the application integrates animated videos, interactive 3D AR visualization, quizzes, and positive reinforcement features within a single learning platform. This study employs the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) with the aim of producing valid, practical, and effective media that can serve as an innovative learning alternative to support the development of social skills in students with autism.

II. Method

This study employed a Research and Development (R&D) methodology aimed at developing and evaluating the quality of an educational product specifically, an Augmented Reality (AR) based social skills learning tool for students with autism. The R&D methodology was chosen because it allows researchers to create an educational product while simultaneously assessing its validity, practicality, and effectiveness. The study was conducted at the Mutiara Hati Special School for Autism in Surabaya with a test group of 10 students with autism in the lower grades of the special school.

Tabel 1. Demographic Characteristic of Participants

Characteristic	Value
Number of participants	10
Age range	7-8 years
Male	9
Female	1
Autism severity level	Moderate ASD

The participants consisted of 10 students with Autism Spectrum Disorder (ASD), aged between 7 and 8 years. Nine participants were male and one participant was female. Based on school records and teacher assessments, all participants were categorized as having moderate ASD.

This study employed the ADDIE development model consisting of Analysis, Design, Development, Implementation, and Evaluation stages (Branch, 2009; Molenda, 2015). During the analysis stage, learning needs, the characteristics of students with autism, and the social skills challenges they face were identified. The design stage involved creating instructional materials, media layouts, educational videos, AR objects, and research instruments. Next, in the development stage, AR-based learning media were created and the product was validated by media experts, subject matter experts, and practitioners. The implementation stage involved pilot testing of the media with autistic students. The evaluation stage aimed to assess the quality of the product based on validation results, practicality of use, and the effectiveness of the developed media.

The data collection methods used in this study included questionnaires and tests. Questionnaires were used to gather data on the validity and practicality of the media through evaluations by media experts, subject matter experts, and practitioners. Meanwhile, tests were used to measure improvements in students' social skills through pre-test and post-test activities. The assessment instrument used a five-point Likert scale with a score range of 1 to 5, ranging from the category of very poor to very good.

Validity and practicality data were analyzed using quantitative descriptive methods based on product feasibility percentages. The evaluation criteria were categorized as highly feasible, feasible, somewhat feasible, less feasible, and not feasible. Meanwhile, the data on media effectiveness were analyzed by comparing pre-test and post-test results. To determine the difference in results before and after media use, the nonparametric Wilcoxon Signed Rank Test was used because the data came from the same, paired groups. The learning media were deemed effective if there was an improvement in students' social skills learning outcomes after using Augmented Reality-based learning media.

This research method was designed to produce an Augmented Reality-based social skills learning tool that is not only suitable for use but also practical and effective in helping to improve students' ability to empathize and respect their peers, as well as reduce harmful behavior toward peers among students with autism.

III. Results and Discussion

A. Results and Findings

This study resulted in the development of an Augmented Reality (AR)-based social skills learning tool designed to help students with autism understand and practice social skills in their daily lives. The product was developed using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) and is accessible via Android-based smartphones. The developed media includes educational animated videos, an AR scanning feature, interactive 3D objects, and evaluation quizzes based on social skills material, covering the ability to empathize, respect peers, and refrain from attacking or hurting peers.

The development process began with an analysis of the needs of students with autism at the Mutiara Hati Special Education School for Autism in Surabaya. The results of the analysis indicated that the students required engaging, visual, and interactive learning materials to help them understand social skills concepts, which remain abstract. Based on these needs, an AR-based learning medium was developed that integrates visual, audio, and digital interaction elements to better align with the learning characteristics of students with autism. After the development process was completed, the product was validated by media experts, subject matter experts, and practitioners to gather feedback regarding the quality of the medium and the appropriateness of the presented content.

The validation results indicate that the educational media developed meets the criteria for use in teaching social skills. Furthermore, the usability test results show that the media is easy to use for both teachers and students. The engaging visual design, simple language, and interactive features of the media help to increase student attention and engagement throughout the learning process.

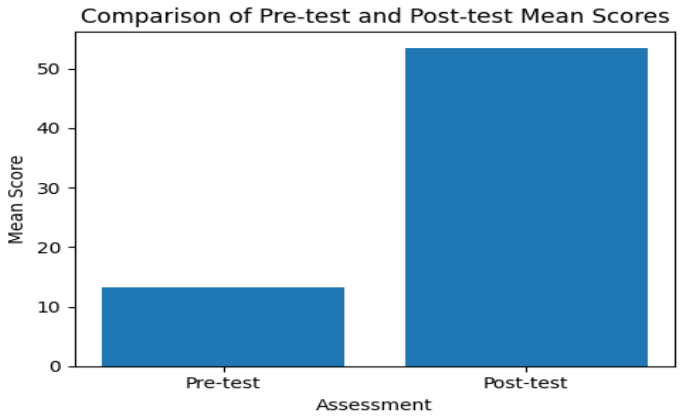
Table 2. Validation Result for the AR-Based Social Skills Learning Materials

Validator	Persentase (%)	Category
Subject Matter Expert	92,94	Highly Recommended
Media Expert	88,00	Highly Recommended
Users	89,00	Highly Recommended

An effectiveness test was conducted on 10 students with autism by administering a pre-test before using the media and a post-test after using the media. The results showed an improvement in social skills after the students used the AR-based learning media. Data analysis was performed using the Wilcoxon Signed Rank Test, which revealed a significant difference in results before and after the intervention, indicating that the developed media is effective in improving the social skills of students with autism.

Tabel 3. Comparison of Pretest and Posttest Result for Social Skills

Testing Phase	Average Score
Pretest	13,20
Posttest	53,50
Improvement	40,30



Before the implementation stage, students were introduced to the AR-based learning application. On average, students required approximately 60 minutes to become familiar with the application's features, including scanning AR markers, accessing learning videos, viewing 3D objects, and completing quizzes. During the initial session, several students required teacher guidance to operate the application. However, after guided practice, all students were able to use the application independently.

Table 3 shows an improvement in students' social skills after using augmented reality-based learning media. The mean score on the pre-test was 13.20, while the mean score on the post-test increased to 53.50. These findings indicate that social skills-based learning media contribute positively to the improvement of social skills in students with autism. To determine the significance of this increase, an analysis was conducted using the Wilcoxon Signed-Rank Test, as shown in Table 4

Table 4. Result of the Wilcoxon Signed-Rank Test

		N	Mean Rank	Sum of Ranks
Post-test – Pre-test	Negative Ranks	0[a]	.00	.00
	Positive Ranks	10[b]	5.50	55.00
	Ties	0[c]		
	Total	10		

a. Post-test < Pre-test
b. Post-test > Pre-test
c. Post-test = Pre-test

Table 5. Test Statistics[a]

	Post-test - Pre-test
Z	-2.842[b]
Asymp. Sig. (2-tailed)	.004

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks

The results of the Wilcoxon test showed an Asymp. Sig. (2-tailed) value of 0.004 (< 0.05), indicating a significant difference between the pretest and posttest scores. These results suggest that the use of the augmented reality-based learning media is effective in improving the social skills of students with autism.

B. Discussion

The results of this study indicate that the Augmented Reality-based social skills learning media developed in this study can serve as a suitable learning alternative for students with autism. This finding aligns with Silva's (2024) assertion that learning media tailored to the visual learning characteristics of children with autism can enhance students' attention, motivation, and understanding of the material presented. By integrating virtual objects with the real environment, AR technology provides a more concrete learning experience, making it easier for students to understand social skills concepts that were previously difficult to grasp in an abstract manner.

The success of the developed media is also supported by the use of visual, audio, video, and animated elements, as well as three-dimensional objects, which help improve the learning focus of students with autism. These features align with the needs of students with autism, who tend to find it easier to understand information presented visually rather than verbally. Therefore, the use of AR technology can help students have a more engaging and meaningful learning experience

The findings of this study also support the results of Berenguer et al. (2020), who found that augmented reality technology can improve the social skills of children with autism, particularly in understanding facial expressions and nonverbal communication. Furthermore, Radu et al. (2020) found that AR-based systems can help children with autism recognize emotions and strengthen

social skills in daily life. Thus, the results of this study reinforce the empirical evidence that AR technology has great potential for use in teaching social skills to students with autism.

The improvement in students' learning outcomes following the use of the media is also consistent with the research by Miningrum (2021) and Mar'atullatifah (2023), which showed that Augmented Reality-based media can enhance the understanding and learning outcomes of children with autism. In this study, improvements in social skills were evident in the students' ability to understand empathetic behavior, respect their peers, and reduce aggressive or harmful behavior toward their peers. These results indicate that AR-based learning media are not only visually engaging but also capable of having a positive impact on the achievement of learning objectives.

Overall, the research findings demonstrate that the Augmented Reality-based social skills learning tool developed in this study exhibits good levels of feasibility, practicality, and effectiveness. This tool can serve as an innovative learning resource in special education, particularly to help students with autism develop the social skills needed in daily life. Furthermore, the developed media also has the potential to be used by teachers and parents as a more interactive learning tool that aligns with current advancements in educational technology.

The implementation of AR-based learning materials also requires active teacher involvement. In this study, teachers acted as facilitators by guiding students during the initial familiarization stage and reinforcing the social skill concepts presented in the application. Brief teacher training regarding AR operation and classroom integration may further enhance the effectiveness of AR-based instruction for students with autism.

Compared with conventional video-based instruction, AR provides a more interactive learning experience by allowing students to interact with virtual three-dimensional objects. In comparison with role-play activities, AR offers structured visual support that may be beneficial for students with autism who experience difficulties in social communication. Therefore, AR can complement existing instructional approaches in social skills education.

IV. Conclusion and Suggestion

This study successfully developed an Augmented Reality (AR)-based social skills learning tool for students with autism using the ADDIE model. The tool includes instructional videos, interactive AR objects, and assessment quizzes designed to help students understand social skills, such as empathy, respecting peers, and not hurting others. The results of the study indicate that Augmented Reality-based learning media meet the criteria of being valid, practical, and effective for use in education. The use of this media can improve the social skills of students with autism and provide a more engaging and interactive learning experience. Therefore, Augmented Reality-based learning media are suitable for use as an alternative learning tool to support the development of social skills in students with autism.

Based on these findings, it is recommended that (1) for teachers, Augmented Reality-based learning media can be used as an alternative teaching method to improve the social skills of students with autism. (2) For schools, it is necessary to provide facilities and infrastructure that support the use of technology-based media in the learning process. (3) For future researchers, it is recommended to develop media with broader content and to test its effectiveness on different subjects and educational levels. (4) For parents, this media can be utilized as a supplement to learning at home to reinforce the social skills taught at school.

This study has several limitations. First, the number of participants was relatively small and involved only one special school. Second, the study employed a one-group pretest-posttest design without a control group, limiting the generalizability of the findings. Future studies should involve larger samples and experimental designs to further examine the effectiveness of AR-based social skills learning materials.

Future research should explore the integration of AR-based learning materials into special education curricula and investigate their long-term impact on students' social skills development. Teacher training programs should also be developed to support the effective implementation of AR technology in classroom settings.

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