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The development of ARQUANA: Qur'anic snakes and ladders based on augmented reality to improve the social behavior of children with mild intellectual disabilities

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Abstract

This study aims to develop and evaluate the effectiveness of ARQUANA, an interactive learning media grounded in Qur'anic values, designed to enhance the social behavior of children with mild intellectual disabilities. By integrating Augmented Reality (AR) technology, ARQUANA provides a more engaging and meaningful learning experience for students at Special Needs Schools (SLB). This research adopts a research and development (R&D) approach using the ADDIE model, encompassing the stages of analysis, design, development, implementation, and evaluation. Validation by instructional media and education experts yielded high scores in both content and media aspects, with an average of 89%. Practicality data indicated that the game and guidebook were user-friendly for teachers or facilitators, with an average score of 86.5%. Furthermore, effectiveness data based on teacher assessments showed that ARQUANA successfully improved students' social behavior—such as honesty, cooperation, and responsibility—with an average effectiveness score of 89%. Trial results also demonstrated significant improvements in students' social behavior, supported by teacher observations. This research contributes to the development of innovative Qur'an-based learning media for children with disabilities, with the expectation of support from various stakeholders to optimize its implementation in inclusive education.

Keywords: Augmented Reality; Qur'anic values; inclusive learning; social behavior; mild intellectual disability

INTRODUCTION

As of 2023, children with disabilities in Indonesia still face significantly lower opportunities to access and complete their education compared to their non-disabled peers. According to UNICEF Indonesia (2023), 36% of children with disabilities do not

attend school, in contrast to only 8% of children without disabilities. Despite the guarantee of educational rights for every citizen under Law No. 20 of 2003, many children with disabilities continue to struggle in accessing appropriate and inclusive formal education.

Education plays a crucial role in the advancement and development of a nation. It is one of the most vital factors in human life, aiming to cultivate character, morality, and cognitive development in children (Safitri et al., 2022). The 1945 Constitution Article 31 Paragraph 1, and Law No. 2 of 1989 concerning the National Education System, affirm that every citizen has the right to equal access to education. This includes children with special needs, who deserve the same opportunities as their non-disabled peers (Ratnaningrum, 2022).

Children with special needs possess characteristics that differ significantly from other children. They are individuals with specific physical, emotional, or mental limitations (Sofia Sari, 2022). One of the major groups within this category is children with intellectual disabilities, commonly referred to as *tunagrahita*. These children experience challenges in intellectual and social development. Intellectual disability is characterized by limitations in cognitive function and adaptive skills, including communication, social interaction, and daily life activities (Farhati et al., 2023).

These challenges often result in difficulty interacting with others at home, in school, or in the broader community. One of the key obstacles faced by intellectually disabled children is the lack of effective and appropriate educational media (Opi Andriani et al., 2023). Consequently, specialized strategies are needed to engage children with intellectual disabilities in the learning process (Sulastri, 2023).

An example is SLB Negeri Jenangan in Ponorogo, a special needs school facing challenges in teaching social behavior to students with intellectual disabilities. Instruction in social values based on the Qur'an is not yet comprehensive, although the school does promote independence through life-skills learning such as sweeping, brushing teeth, bathing, and simple daily tasks. Social programs such as group learning are also present but remain limited due to the lack of appropriate learning media, resulting in low student engagement.

Existing learning media often fall short in helping children with intellectual disabilities develop the necessary social skills to engage with their environment. These limitations hinder not only their personal development but also their ability to fully participate in social and educational activities.

The development of appropriate and inclusive educational media is essential. Effective media should stimulate and support the learning process while bridging existing educational gaps. Such media should be tailored to the needs and abilities of children with disabilities (Redho Al Faritzi et al., 2024; Hikmah, 2024). Moreover, instilling Qur'anic social values in Muslim children—including those with intellectual disabilities—is crucial for fostering a morally upright generation. Therefore, innovative learning media are required—those that are both engaging and effective in nurturing social and moral competencies.

Meanwhile, technological advancements present new opportunities in education. One such promising tool is Augmented Reality (AR), which combines real-world environments with digital elements in real-time, creating immersive and interactive experiences (Rakhmadi Rahman et al., 2024). In educational settings, AR

enhances student engagement and supports the understanding of abstract concepts, especially for children with intellectual disabilities (Kurniawan & Avianto, 2023).

Moral and religious values also play a critical role in character building. For children with intellectual disabilities, it is essential to present Qur'anic values such as honesty, patience, tolerance, and compassion in ways that are easy to understand and relevant to their needs. Integrating these values into technology-based learning media offers a promising approach to enhancing the quality of education for this group.

ARQUANA (Augmented Reality Qur'anic Adventure) is introduced as an innovative solution that merges the traditional "snakes and ladders" game with AR technology and Qur'anic values. Designed to offer an engaging and meaningful learning experience, ARQUANA aims to enhance social behavior in intellectually disabled children by teaching them moral concepts like honesty, respect, and kindness in an enjoyable manner.

Game-based learning is recognized for its ability to improve student motivation and social skill development. For intellectually disabled children, this method is especially effective, as they tend to learn through direct experiences and concrete activities. Through ARQUANA, it is hoped that students will not only enjoy the learning process but also internalize valuable social behaviors that help them integrate more effectively into their social environments.

The development of ARQUANA seeks to provide a concrete solution to the challenges faced in educating intellectually disabled children—particularly in fostering social behavior and implementing Qur'anic values. This game also serves as a model for the application of AR technology in inclusive learning, demonstrating its potential for both educational and social benefits.

METHOD

Research Design, Time, and Location

This research was conducted at SLB Negeri Jenangan Ponorogo using a Research and Development (R&D) methodology to create and evaluate the ARQUANA game. The study followed the ADDIE model, which includes five key stages: Analysis, Design, Development, Implementation, and Evaluation (see Figure 1). Each stage was implemented to ensure that the developed game met the research objectives and addressed the specific needs of the students.

Analysis (Curriculum, Students, Concepts, and Teachers), Literature Review, and Focus Group Discussion (FGD)

The initial phase involved comprehensive analysis in several areas: curriculum analysis to align ARQUANA with the learning objectives of children with mild intellectual disabilities; student analysis to understand their cognitive and social characteristics; conceptual analysis to define the Qur'anic values integrated into the game; and teacher analysis to identify instructional strategies and challenges in teaching social behavior. These analyses were supplemented by literature reviews and Focus Group Discussions (FGDs) to validate the design and objectives of the game.

Content Development and ARQUANA Game Design

Based on the results of the analysis phase, the content and structure of the ARQUANA game were developed. This included designing the game board, Qur'anic

value cards, step cards, task cards, and question cards. The materials were structured to reflect Qur'anic social values and were adapted to the learning capacities of children with mild intellectual disabilities. The game elements were also enriched with Augmented Reality (AR) to enhance interactivity and engagement.

Game Development and Expert Validation (Media and Content)

Following the design phase, the ARQUANA game was developed into a prototype and validated by subject matter experts. A media expert evaluated the usability and technical features, while a content expert assessed the alignment of materials with Islamic educational principles. Their feedback informed necessary revisions to optimize the game's instructional quality and accessibility for target users.

Pre-Test, Post-Test, Practicality Questionnaire, and Teacher Response Questionnaire

To evaluate the practicality and effectiveness of the game, a series of instruments were employed. A pre-test and post-test were administered to assess students' knowledge and attitudes related to Qur'anic social values. Practicality was measured using a questionnaire completed by teachers and facilitators after using the ARQUANA game and accompanying guidebook. In addition, a response questionnaire was distributed to teachers to gather qualitative insights into the game's usability, content, and impact.

Product Evaluation

The final phase involved evaluating the ARQUANA product based on data gathered from the previous steps. The results were used to determine the effectiveness of the game in enhancing social behavior and its suitability as a learning tool for children with intellectual disabilities. This comprehensive evaluation ensured that ARQUANA met academic standards and had practical value in real educational settings.

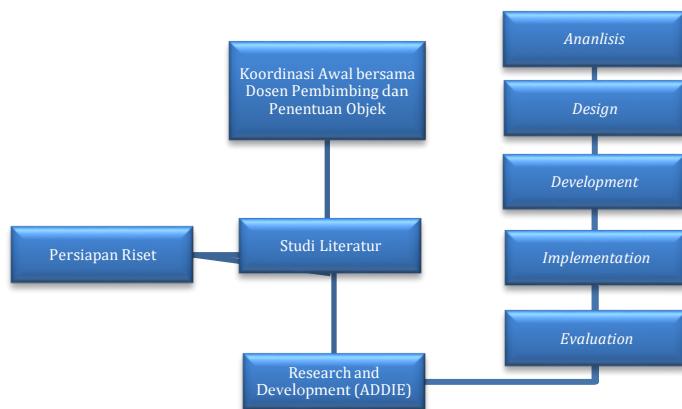


Figure 1 ARQUANA Research Stages

Types and Techniques of Data Collection

This study employed a Research and Development (R&D) approach focused on creating and refining educational media based on Qur'anic values for children with mild intellectual disabilities. Data were collected using multiple techniques. Expert

validation questionnaires were administered to evaluate the validity of the ARQUANA game from the perspective of instructional media specialists. Additionally, teacher response questionnaires were used to assess the feasibility and acceptability of the product from an instructional point of view. The game's effectiveness was measured using pre-test and post-test instruments, aimed at identifying changes in students' knowledge and attitudes regarding social behavior in everyday life. The collected data from expert validations, teacher responses, and pre/post-tests were then analyzed to ensure that ARQUANA met the expected quality and effectiveness standards.

Variables and Measurement

The primary variable in this study was students' knowledge and understanding of social values taught in the Qur'an. Measurement was conducted using a Likert scale embedded in the expert validation and teacher response questionnaires, consisting of five categories ranging from "Very Poor" to "Very Good."

The effectiveness of the ARQUANA game was assessed using pre-test and post-test instruments. Prior to conducting the analysis, prerequisite tests—namely the Normality Test and Homogeneity Test—were performed. Following this, an N-Gain Test was applied to identify significant improvements in students' knowledge and attitudes after engaging with the ARQUANA game. Furthermore, an Independent Sample T-Test was used to compare results between the experimental group and the control group, to determine whether the game had a statistically significant impact on enhancing social behavior in children with mild intellectual disabilities.

Data Processing and Analysis

The data gathered from various research instruments were analyzed to evaluate the validity, practicality, and effectiveness of the ARQUANA game. Expert validation and teacher response data were analyzed using a Likert scale, and the results were presented in percentage form. Game effectiveness was examined through pre-test and post-test comparisons using the T-Test and N-Gain analysis to detect significant improvements in students' social understanding and behavior.

The findings of these analyses were used to refine the product and confirm that ARQUANA could be effectively utilized in the learning process to support the development of social behavior in children with mild intellectual disabilities. The conclusion was drawn based on these data, offering a comprehensive understanding of the game's educational impact from a Qur'anic values perspective.

DISCUSSION AND ANALYSIS

Intellectual Disability (Tunagrahita)

Intellectual disability, or *tunagrahita*, is a form of mental retardation in which a child experiences delays in cognitive, physical, emotional, and social development. These children require special support to optimize their developmental potential. They often show significantly below-average intellectual functioning and face difficulties in academic tasks, communication, and social interaction. Consequently, they require tailored educational services that accommodate their needs (Sulastri, 2023).

Generally, children with intellectual disabilities exhibit several characteristics: (1) slower developmental milestones compared to peers; (2) confusion or anxiety when confronted with new situations; (3) very short attention spans; (4) limited language and

communication skills, often accompanied by stuttering; (5) lack of self-help skills; (6) extremely low learning motivation; (7) erratic developmental progress; and (8) lack of environmental awareness (Putri Soleha, 2022).

The classification system used in Indonesia (PP No. 72/1999) identifies three levels of intellectual disability: mild (IQ 50–70), moderate (IQ 30–50), and severe to profound (IQ below 30) (Widiastuti & Winaya, 2019). This study focused on children with mild intellectual disabilities (IQ 50–70), as determined through interviews with teachers at SLB Negeri Jenangan Ponorogo. It was found that not all children with intellectual disabilities could participate in a snakes and ladders-style game.

Children with intellectual disabilities were chosen for this study because they have unique needs in developing cognitive and social skills. These children often struggle to understand basic social concepts such as empathy, cooperation, and effective communication. They require simpler, more repetitive learning approaches to master these skills.

In this context, a snakes and ladders game infused with Qur'anic values and powered by Augmented Reality presents an appropriate method. It is designed to align with their level of understanding in an engaging and easily digestible format. While children with other disabilities—such as physical impairments or hearing impairments—face different challenges, those with intellectual disabilities need targeted interventions focusing on social behavior and adaptation. These goals can be achieved through games that combine both cognitive and social elements.

The Urgency of Social Behavior in the Qur'an

Social behavior is a crucial component of communal life that reflects the quality of interpersonal relationships within society. The Qur'an, as the primary source of guidance for Muslims, provides clear values and instructions on appropriate social conduct. These teachings aim not only to create harmony within the community but also to cultivate individuals of noble character (Puspa Maharani et al., 2024).

The Qur'an, revealed by Allah to the Prophet Muhammad (SAW), encompasses guidance across three core themes: *tawhīd* (monotheism), historical narratives, and *akhlāq* (moral conduct). The Qur'an offers detailed moral principles, emphasizing traits such as honesty, patience, humility, forgiveness, and respect for others (Aris, 2022).

Moral behavior in Islam—referred to as *akhlāq*—involves both outward actions and inward intentions. It regulates a Muslim's relationship with God, with themselves, and with others. The Qur'an outlines the essential characteristics that individuals should develop to attain success in both this world and the Hereafter (Zahwa Putri Naila et al., 2024).

For instance, in Surah al-Isrā' (17):23, Allah emphasizes kindness and compassion toward parents:

...وَقَضَى رَبُّكَ أَلَا تَعْبُدُوا إِلَّا إِيَّاهُ وَبِالْوَالِدَيْنِ إِحْسَانًا...

"Your Lord has decreed that you worship none but Him, and that you be kind to parents..."

Ibn Kathīr, in his *tafsīr*, highlights the importance of respectful speech and obedience to one's parents, particularly in their old age, as an expression of compassion and piety (Ibn Kathīr, 1999).

Likewise, Surah al-Ḥujurāt (49):11–12 warns against mockery, defamation, and suspicion. According to Quraish Shihab, these verses promote universal principles of

social harmony and are addressed to all humanity, not just the believers. They underline the importance of justice, fraternity, and equality in human relations (Shihab, 2002).

These verses promote values such as justice ('adālah), fraternity, appreciation of others, and the prohibition of *ghibah* (backbiting) (Jannah et al., 2021). The implementation of such values is essential in daily life as a manifestation of faith. In the context of educating children with intellectual disabilities, embedding *akhlāq* values from the Qur'an through interactive tools such as ARQUANA can be highly effective in shaping positive social behavior.



Figure 2 Game Board
ARQUANA



Figure 3 Game Card ARQUANA

ARQUANA (*Augmented Reality Qur'anic Adventure*)

ARQUANA is a snakes and ladders game embedded with Qur'anic values, specifically designed to improve the social behavior of children with mild intellectual disabilities. It employs Augmented Reality (AR) technology integrated into game cards, which display 3D visuals, animations, or text that correspond to values such as honesty, cooperation, and patience.

The game has three primary objectives:

1. To enhance children's social behavior through engaging, interactive play.
2. To teach core Qur'anic values—such as cooperation, mutual respect, and honesty—in an accessible manner.
3. To develop children's social and communication skills through group-based gameplay.

ARQUANA features several key components:

1. **Game Board:** A traditional snakes and ladders board enhanced with AR features. Each space represents a Qur'anic social value.

2. **Qur'anic Value Cards:** Cards drawn upon landing on specific spaces; they contain verses or *hadiths* related to values, with animated AR illustrations.
3. **Player Tokens:** Tokens represent Islamic concepts or values and appear as 3D characters via AR.
4. **Step Cards:** These replace dice and are written in Arabic, English, and Indonesian, promoting language development.
5. **Question and Task Cards:**
 - a. *Question Cards* ask simple value-based questions, answered with AR-supported visuals.
 - b. *Task Cards* assign positive social actions, such as complimenting a peer, with corresponding AR animations.

With the combination of physical gameplay and immersive digital content, ARQUANA offers an innovative tool for supporting Qur'an-based social learning.

RESULTS

Analysis Stage

During the initial development of the ARQUANA game, several types of analysis were conducted to ensure alignment with the needs of students with mild intellectual disabilities:

1. Curriculum Analysis

ARQUANA was designed to support the special education curriculum, particularly for students with mild intellectual disabilities. This curriculum emphasizes social skills development, character education, and fostering independence. The game integrates Qur'anic values such as honesty, cooperation, and gratitude, complementing Islamic moral instruction. With a thematic and contextual approach, ARQUANA serves as a bridge from theoretical learning to practical application.

2. Environmental Analysis

A conducive learning environment is essential for successful implementation. Physically, ARQUANA can be played in classrooms or small activity areas using safe and simple components. Socially, it encourages collaborative interaction among students, promoting communication, cooperation, and empathy. Teacher and parental support is also crucial to ensure that learning objectives are achieved.

3. Student Analysis

Students with mild intellectual disabilities often struggle with complex information processing. Thus, ARQUANA was designed with simplicity, using easily understood instructions, attractive visuals, and accessible language. The game focuses on developing key social skills such as politeness, helpfulness, and mutual respect. Its interactive approach aims to enhance motivation and learning interest.

4. Concept Analysis

ARQUANA promotes social skills through an engaging and educational gameplay experience. The game integrates Qur'anic values through elements like task cards, value cards, and question cards. Its flexible design allows for use at school or at home, encouraging children to apply moral principles—such as honesty, gratitude, and cooperation—in everyday life.

5. Teacher Analysis

Teachers act as facilitators in the implementation of ARQUANA. They guide students during gameplay and ensure that Qur'anic values are understood and practiced. Teachers must comprehend the game's mechanics to effectively lead sessions and assess students' social development. Cooperation with parents is also vital to reinforce learning outside the classroom.

Design Stage

At this stage, the learning materials, interactive game components, and assessment instruments (questionnaires) were developed to support the improvement of social behavior in students with intellectual disabilities. This phase involved the modification of conventional snakes and ladders elements, such as replacing dice with Step Cards and introducing Qur'anic Value Cards, Task Cards, and Question Cards to deliver moral messages and encourage social behavior.

All cards were designed with engaging visual elements, and the player tokens were created as symbolic characters representing Islamic values. The game board was child-friendly, featuring Qur'anic symbols and a simplified layout tailored to the cognitive abilities of students with intellectual disabilities.

Development Stage

In this phase, the ARQUANA game was produced based on the finalized design. Educational media experts validated the initial product. Based on their feedback, the game was revised to ensure functionality and alignment with its educational goals. The results of this validation are presented below:

1. **Media Expert Validation (Validator 1):** 93% (very valid)
2. **Content Expert Validation (Validator 2):** 85% (very valid)
3. **Practicality Test by Two Teachers:** 89% and 84% (practical)
4. **Effectiveness Evaluation:** 88% and 90% (effective)

Overall, the average validation score was 89%, confirming the game's validity in terms of content and media. The average practicality score was 86.5%, indicating ease of use by teachers or facilitators. The average effectiveness score was 89%, suggesting the game effectively enhanced students' social behavior based on Qur'anic values. These results demonstrate that ARQUANA is ready for implementation in special education settings as a Qur'an-based social learning tool.

Implementation Stage

The implementation phase involved field testing of the ARQUANA game in actual classroom settings. A pre-test was administered to measure students' prior knowledge of Qur'anic social values. After engaging with ARQUANA, a post-test was conducted to assess changes in students' understanding and behavior. This stage aimed to observe the game's practical application and evaluate its impact on improving students' social skills.

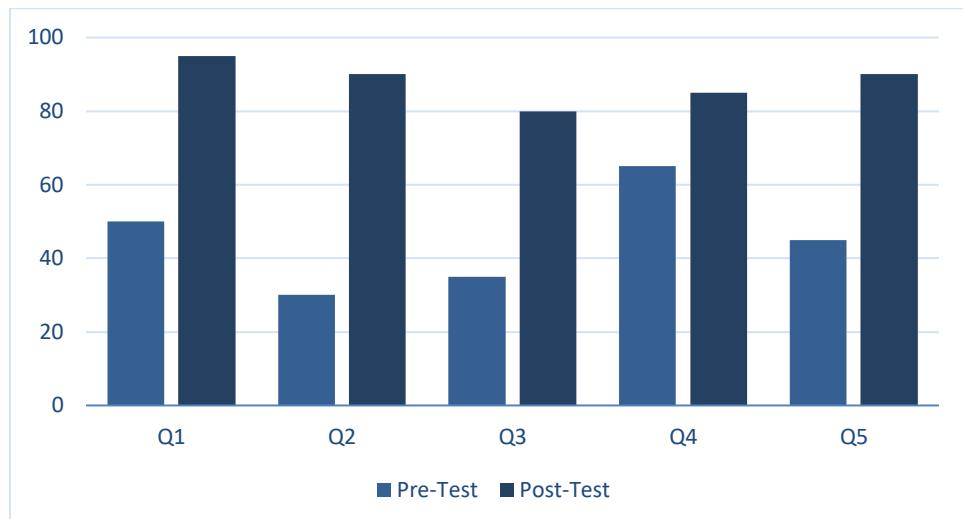


Figure 4 Student Achievement Scores

Evaluation Stage

The evaluation phase was conducted to measure the achievement of the game's learning objectives. Data from the pre- and post-tests were analyzed using statistical methods, including the T-Test, N-Gain Test, and prerequisite tests (Normality and Homogeneity). The T-Test result yielded a *p*-value of 0.001, indicating a statistically significant effect. This finding confirms that the ARQUANA game effectively improved students' knowledge and behavior concerning Qur'anic social values.

CONCLUSION

Based on the findings of this study, it can be concluded that ARQUANA is an effective educational medium for improving the social skills of children with mild intellectual disabilities. Through this interactive game, children are able to learn positive social values such as empathy, cooperation, and communication in an engaging and easily comprehensible manner.

The implementation of ARQUANA in special education settings demonstrates its potential in supporting children to develop appropriate social behavior, thereby enhancing their ability to interact within their social environment. The game successfully integrates Qur'anic values into educational activities, making moral teachings more accessible and enjoyable for students with special needs.

Furthermore, the success of ARQUANA's application depends significantly on the support of educators, parents, and the broader community. Their active involvement is essential to ensure the continuity and sustainability of this game-based learning approach in various inclusive educational contexts.

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