

ENHANCING STUDENT ENGAGEMENT IN ISLAMIC RELIGIOUS EDUCATION THROUGH A FINITE-STATE MACHINE AND GUIDED INQUIRY-BASED SERIOUS GAME

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Abstract: This study aims to develop interactive learning media in the form of a serious game based on Finite State Machine (FSM) and guided inquiry approach to improve student engagement and understanding of Islamic Education material, especially the exemplary story of Ashabul Kahfi. The research method used is Research and Development (R&D) with the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model. The game was developed with enemy characters based on Finite State Machine (FSM), consisting of three main

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conditions: patrol, pursuit, and return to the path, to create dynamics and challenges in educational games. Fourth-grade elementary school students were the main subjects in testing the effectiveness of the media, which involved pre-tests and post-tests to measure learning outcome improvement, as well as validation by subject matter and media experts. The results showed that the developed media met the feasibility criteria with a subject matter expert validation score of 3.5 and a media expert validation score of 4.0, as well as an N-Gain value of 0.53, which is in the moderate category. These findings indicate that the combination of FSM and guided inquiry methods in serious games can create an interactive, enjoyable, and effective learning experience that increases student engagement and critical thinking skills in PAI material. The research results recommend this media as an alternative for interactive digital learning at the elementary school level.

Keywords: Finite-State Machine, Guided Inquiry, Islamic Religious Education, Serious Game, Student Engagement

Introduction

Digital transformation in education has driven the emergence of various technology-based learning innovations, one of which is interactive learning media in the form of serious games. A serious game is a digital game that is not intended solely for entertainment but is specifically designed to carry educational value and support the learning process ¹. This innovation is considered effective in increasing student engagement, learning motivation, and critical-thinking skills in the context of 21st-century learning ².

¹ A. A. Yunanto and S. Rochimah, "Systematic Literature Review Terhadap Evaluasi Perangkat Lunak Tentang Serious Game," *Jurnal Informatika* 4, no. 1 (2017).

² A. B. Wijaya, S. Suliswaningsih, and A. D. Pritama, "Meningkatkan Rasa Nasionalisme Siswa Melalui Game Base Learning," *Matrik: Jurnal Manajemen, Teknik Informatika Dan Rekayasa Komputer* 19, no. 1 (2019): 196–204.

In practice, however, the use of computer technology for teaching Islamic Religious Education (PAI) at the elementary school level remains far from optimal. Observations conducted by the researcher in several elementary schools show that although teachers have used information and communication technology-based learning media, this use is generally limited to PowerPoint as a presentation tool. This medium tends to be one-directional, with the teacher actively delivering material while students merely act as passive recipients of information. This condition results in low active student engagement in learning and limited opportunities to explore the material independently. Meanwhile, an effective learning process should be able to provide an interactive, exploratory, and enjoyable experience ³.

Along with advances in information and communication technology, learning media have become increasingly diverse and innovative. ICT provides teachers with opportunities to innovate in creating learning experiences that are more engaging, interactive, and meaningful ⁴. Teachers are expected to be careful in selecting and designing appropriate media to help students understand the material being taught, particularly in subjects containing abstract values such as Islamic Religious Education ⁵. Islamic Religious Education (PAI) is often perceived by students as less engaging due to one-directional and monotonous delivery methods. This is a particular challenge,

³ A. K. Adisusilo, "Perancangan Media Pembelajaran Tematik Sekolah Dasar Berbasis Serious Game," *Matrix: Jurnal Manajemen Teknologi Dan Informatika* 10, no. 3 (2020): 123–132. S. H. Amalia, A. Purwanto, and E. Risdianto, "Pengembangan Media Pembelajaran Game Edukasi Fisika (GEMIKA) Berbantuan Wordwall Untuk Meningkatkan Motivasi Belajar Siswa SMA," *Jurnal Penelitian Pembelajaran Fisika* 15, no. 2 (2024): 222–232.

⁴ S. Rohmah and I. M. Tegeh, "Multimedia Interaktif Untuk Meningkatkan Minat dan Hasil Belajar PAI," *Jurnal Edutech Undiksha* 10, no. 2 (2022): 215–224.

⁵ S. Asela, U. H. Salsabila, N. H. P. Lestari, A. Sihati, and A. R. Pertiwi, "Peran media interaktif dalam pembelajaran PAI bagi gaya belajar siswa visual," *Jurnal Inovasi Penelitian* 1, no. 7 (2020): 1297–1304.

given that the exemplary values in Qur'anic stories such as that of Ashab al-Kahf require a relevant approach capable of directly touching students' learning experience.

In the learning process, educators play an important role in creating an engaging learning environment while fostering students' positive attitudes toward the material being taught ⁶. One way to achieve this is by utilizing learning media that is engaging and suited to students' characteristics. Learning media are media used to explain particular concepts, principles, or procedures so that they are easier for students to understand and appear more clearly ⁷. With advances in information and communication technology, digital-based learning media have become increasingly popular because they can offer an interactive and motivating learning experience. One innovation among such media is the serious game, a digital game designed not only for entertainment but also for education ⁸. By adopting a guided-inquiry approach, a serious game can invite students to actively explore, ask questions, and draw conclusions under the teacher's direction, thereby supporting a more meaningful learning process.

A game is a structured activity governed by a set of rules aimed at achieving a particular outcome. In education, games combined with digital technology are known as technology-based games and function as engaging, interactive learning media. Such games are built using computer software so that they can be easily accessed by students and can support an enjoyable learning experience.

⁶ A. Arianti, "Urgensi lingkungan belajar yang kondusif dalam mendorong siswa belajar aktif," *Didaktika: Jurnal Kependidikan* 11, no. 1 (2017): 41–62.

⁷ M. S. Saleh, S. Syahrudin, M. S. Saleh, I. Azis, and S. Sahabuddin, *Media pembelajaran* (2023). F. T. S. Utomo, "Inovasi Media Pembelajaran Interaktif Untuk Meningkatkan Efektivitas Pembelajaran Era Digital Di Sekolah Dasar," *Pendas: Jurnal Ilmiah Pendidikan Dasar* 8, no. 2 (2023): 3635–3645.

⁸ C. B. Pratama, "Pengembangan Media Game Bertema Serious Game Sebagai Pembelajaran Berbasis Ice Breaking," *Seminar Nasional Teknologi & Sains* 3, no. 1 (2024): 139–144.

When developing a serious game for education, it is essential to attend to several criteria so that the game succeeds in delivering the subject matter⁹. The criteria that need to be met include: (a) Usability: the game must be easy to use, have a simple interface, and be equipped with clear instructions so that students can play it without difficulty; (b) Accuracy: the game's content must be accurate and relevant to the material being taught. In this case, the story of Ashab al-Kahf must be presented accurately, based on trustworthy sources within Islamic teaching; (c) Suitability: the game must be tailored to the needs and characteristics of its users, namely fourth-grade elementary school students. The difficulty level, language, and visual design must correspond to their stage of cognitive development; (d) Relevance: the game's content must be able to guide students toward achieving the learning objective, namely understanding the exemplary values of the story of Ashab al-Kahf; (e) Objectivity: the game needs a clear evaluation system to indicate the player's success or failure in achieving the learning objectives; (f) Feedback: the game should provide immediate feedback in visual or audio form to help students understand the actions they take within the game; (g) Attractiveness: a game with strong visual appeal and engaging gameplay will encourage students to keep participating while learning. Elements such as a strong narrative, appealing graphics, and well-balanced challenges greatly influence students' sustained interest in learning; (h) Motivation: a well-designed game can increase students' learning motivation, whether through a point system, achievements, or the rewards of completing in-game challenges.

This study proposes the development of a serious game based on the guided-inquiry method, which allows students to learn through a process of exploration, observation, and meaning-making that is active yet still directed. The guided-inquiry approach has been shown

⁹ A. M. Fahrul, "Pengertian Game Online dan Dampaknya," *Jakarta Media Anak* (2010).

to foster the development of students' critical-thinking skills and deeper conceptual understanding ¹⁰.

Besides pedagogical considerations, the technical aspects of the game are also key to creating a challenging and realistic learning experience. One relevant approach for developing enemy character behavior in games is the Finite State Machine (FSM). FSM enables the implementation of simple yet effective artificial intelligence to govern dynamic enemy behavior, such as patrolling, chasing, and returning to a path. Integrating FSM into a serious-game system can create immersive interaction and encourage students to think strategically while interacting with the game environment.

The development of digital technology has transformed the function of games from mere entertainment into a beneficial educational medium. One innovation among educational games is the serious game, a game created with the primary purpose of educating, training, or conveying particular information without entirely removing the enjoyable elements of play ¹¹. A serious game combines entertaining interactive elements with content rich in values and information, thereby providing an effective learning experience. In education, a serious game serves as a means of offering an active and participatory learning atmosphere. It allows students to independently construct knowledge through interaction, exploration, and problem-solving within a directed and controlled virtual world ¹². The learning experience offered by a serious game can deepen conceptual understanding, increase emotional engagement, and develop students' critical and reflective thinking abilities.

¹⁰ M. J. Hapsari, "Upaya meningkatkan self-confidence siswa dalam pembelajaran matematika melalui model inkuiri terbimbing," *Prosiding Seminar Nasional Matematika Dan Pendidikan Matematika UNY* 30, no. 1 (2011): 337–345. E. Lovisia, "Pengaruh model pembelajaran inkuiri terbimbing terhadap hasil belajar," *SPEJ (Science and Physic Education Journal)* 2, no. 1 (2018): 1–10.

¹¹ Yunanto and Rochimah, "Systematic Literature Review Terhadap Evaluasi...."

¹² A. Hidayatno, A. R. Destyanto, and M. R. N. Iman, *Bermain untuk Belajar: Merancang Permainan Sebagai Media Pembelajaran yang Efektif* (Penerbit LeutikaPrio, 2018).

The use of serious games in education offers a number of significant advantages, particularly in improving the quality and efficiency of learning at the elementary school level. One of the key features of a serious game is its ability to present entertainment and engaging challenges that can capture students' interest and boost their enthusiasm for learning ¹³.

The game created for this study is intended to teach the inspiring story of Ashab al-Kahf to fourth-grade elementary school students through a guided-inquiry approach presented as a serious game. The game concept is divided into several stages that align with the narrative structure and educational values of the story. Each stage is presented as an interactive mission that encourages students to investigate the story, answer inquiry-based questions, and reflect on the values contained within the story of Ashab al-Kahf. The game consists of three main components: (a) the first component: introducing the characters and the story's background; (b) the second component: exemplary values; (c) the third component: reflection and assessment. The game system imposes no time limit on each play session and will end if the player is caught by a guard character, although students may replay it to refine their understanding.

The serious game developed in this study employs the guided-inquiry method, a teaching method that encourages students to participate actively in seeking knowledge through narrative, exploration, and discovery that is systematically guided by the teacher or the game platform. This method is highly suitable for educational games because it supports active student engagement while fostering a deep understanding of the material taught. This study offers novelty by integrating a Finite State Machine (FSM) approach into enemy-character behavior together with the guided-inquiry method as a pedagogical strategy within a serious game themed around Islamic Religious Education. To date, a combination of FSM-based artificial-

¹³ N. P. Yunita and R. E. Indrajit, *GAMIFICATION: Membuat Belajar Seasyik Bermain Game* (Penerbit Andi, 2022).

intelligence elements and an inquiry approach in an educational PAI game—particularly concerning the story of Ashab al-Kahf—remains rarely found in the literature or in elementary-level digital learning implementations.

In the context of teaching the exemplary story of Ashab al-Kahf, the guided-inquiry method gives students the opportunity not only to understand the text of the story but also to connect it with moral and spiritual values relevant to daily life. Through a game mechanism designed around an inquiry scenario, students are encouraged to observe the events in the story, pose critical questions such as “Why did the young men choose to hold fast to their beliefs?”, and search for the meaning and values behind the characters’ behavior in the story.

The guided-inquiry method was chosen for its various advantages. According to Hapsari, this approach gives students the opportunity to learn independently, sharpen higher-order thinking skills, and build self-confidence, as students feel they have control over their own learning process. In addition, students can develop according to their individual potential through logical, critical, and structured thinking activities ¹⁴. Lovisia argues that the inquiry method has characteristics indicating that learning should focus on student activity, encouraging them to seek and discover knowledge independently while actively developing students’ cognitive potential ¹⁵. All of these characteristics are integrated into this serious game through various features such as interactive narrative, search-based missions, reflective quizzes, and decision-making-based challenges.

Several studies have demonstrated that using games as a learning medium can be applied efficiently in the classroom. One example is the study conducted by Vega Vitianingsih, A., in an article entitled “Game Edukasi sebagai Media Pembelajaran Pendidikan Anak Usia Dini” (“Educational Games as a Learning Medium for Early

¹⁴ Hapsari, "Upaya meningkatkan self-confidence siswa dalam...", 337–345.

¹⁵ Lovisia, "Pengaruh model pembelajaran inkuiri terbimbing...", 1–10.

Childhood Education”). This study revealed that the application of educational games in early-childhood learning can boost enthusiasm for learning and make it easier for children to absorb the material being taught. The study’s findings indicate that educational games have significant potential as an enjoyable, participatory learning tool suited to children’s development ¹⁶.

Another study conducted by Windawati, R. and Koeswanti, H. D., entitled “Pengembangan Game Edukasi Berbasis Android untuk Meningkatkan Hasil Belajar Siswa di Sekolah Dasar” (“Development of an Android-Based Educational Game to Improve Elementary Students’ Learning Outcomes”), found that the developed educational game could significantly improve students’ learning outcomes. The medium was found to be valid, practical, and effective, and capable of capturing students’ attention during teaching and learning activities. The use of Android-based technology also made access easier and provided flexibility for learning, both inside and outside the classroom ¹⁷.

This study focuses on developing a serious game built around the guided-inquiry method to convey the exemplary story of Ashab al-Kahf to fourth-grade elementary school students. Analysis of several prior studies reveals that the integration between method-based learning models and educational game media remains very limited. Most available learning applications do not exhibit an organized line of thinking, making them suboptimal in supporting students’ cognitive development. In this study, the researchers developed a serious game intended not only to entertain but also to function as an active learning tool that supports the development of students’ critical and

¹⁶ A. Vega Vitianingsih, "Game edukasi sebagai media pembelajaran pendidikan anak usia dini," *Inform* 1, no. 1 (2016): 25–32.

¹⁷ R. Windawati and H. D. Koeswanti, "Pengembangan Game Edukasi Berbasis Android untuk Meningkatkan hasil Belajar Siswa di Sekolah Dasar," *Jurnal Basicedu* 5, no. 2 (2021): 1027–1038.

reflective thinking abilities¹⁸. The guided-inquiry method was chosen because it gives students the opportunity to explore, experiment, ask questions, and discover concepts independently under clear guidance¹⁹.

This game is designed to stimulate students' inquiry and reasoning processes through a series of challenges related to the story of Ashab al-Kahf. In this game, students discover clues, process information, and form connections between the pieces of knowledge they have acquired. In this way, the game does not merely deliver material passively but also encourages students to actively construct their own understanding²⁰.

This study aims to design and develop a serious-game-based learning medium that combines the guided-inquiry method with a Finite State Machine mechanism, situated within the story of Ashab al-Kahf, for fourth-grade elementary school students. Through this approach, it is hoped that the resulting medium will be valid not only in terms of content and appearance but also effective in enhancing students' understanding and active engagement in the learning process.

Research Method

This study employed a Research and Development (R&D) approach²¹. R&D is a method that focuses on the creation and

¹⁸ A. Tiana, A. D. Sagita Krissandi, and M. Sarwi, "Peningkatan motivasi dan hasil belajar siswa melalui media game quizizz pada mata pelajaran matematika," *Jurnal Pendidikan Indonesia* 2, no. 6 (2021): 943–952.

¹⁹ N. W. Wartini, "Implementasi model pembelajaran inkuiri terbimbing untuk meningkatkan motivasi belajar dan kemampuan berpikir kritis," *Journal of Education Action Research* 5, no. 1 (2021): 126–132.

²⁰ A. Pratiwi, F. Hikmah, A. A. Adiansha, and S. Suciya, "Analisis penerapan metode games education dalam meningkatkan motivasi belajar siswa sekolah dasar," *JagoMIPA: Jurnal Pendidikan Matematika Dan IPA* 1, no. 1 (2021): 36–43.

²¹ S. Sugiyono, "Metode penelitian kuantitatif dan kualitatif dan R&D," *Alfabeta Bandung* 14 (2010).

evaluation of a particular product. In this study, the media-development design follows the ADDIE model, which comprises five stages: analysis, design, development, implementation, and evaluation. This media-development project aims to produce a serious game based on the guided-inquiry method, built around the exemplary story of Ashab al-Kahf, for fourth-grade elementary school students. The development process and feasibility testing of the medium involved material experts, media experts, and fourth-grade students as trial participants. This study therefore not only produces innovative learning material but also tests the extent to which the resulting product is feasible and effective for use in the learning process.

This study was conducted on 12 April 2025 at SD Negeri 1 Pakisaji in Malang Regency. The subjects of this study comprised 18 fourth-grade students of SD Negeri 1 Pakisaji in the 2024–2025 academic year. The main objective of this study was to develop a digital learning medium in the form of a guided-inquiry-based serious game themed around the exemplary story of Ashab al-Kahf. This study used the ADDIE development model, comprising five stages: analysis, design, development, implementation, and evaluation. The ADDIE model was applied as the guiding framework for the media-development process. The ADDIE development paradigm applied here is an instructional-systems model created by Dick and Carey, which emphasizes the importance of an iterative, organized process in designing, developing, and evaluating learning media so that the resulting product is effective and of high quality ²².

A questionnaire served as the main instrument for data collection. It was designed to assess the feasibility of the learning medium that had been produced, from both content and technical perspectives. The medium was evaluated by considering several factors, including content validity, material structure, the quality of practice questions, language use, software technical aspects, and visual

²² R. D. Prasasti and N. Anas, "Pengembangan media digital berbasis flipbook untuk meningkatkan kemampuan berpikir kritis pada peserta didik," *Munaddhomah: Jurnal Manajemen Pendidikan Islam* 4, no. 3 (2023): 694–705.

appeal and aesthetics. This instrument was administered to experts, including material and media experts, as well as to users (students), to understand their responses to the serious-game medium that had been created. The data obtained from the questionnaire were then analyzed to determine the extent of the medium’s feasibility and efficiency as an interactive learning tool for fourth-grade elementary school students.

Table 1. Scoring Guidelines for the Validation Questionnaire

Score	Criterion
5	Very good
4	Good
3	Fairly good
2	Poor
1	Very poor

To determine the validity of the guided-inquiry-based serious game, the following table of learning-tool validity criteria can be used.

Table 2. Validity Criteria for Learning Tools

Score	Criterion
$3.5 \leq Sr < 4.0$	Highly valid
$2.5 \leq Sr < 3.5$	Valid
$1.5 \leq Sr < 2.5$	Invalid
$1.0 \leq Sr < 1.5$	Highly invalid

An evaluation of the extent to which the serious-game medium is effective as a learning medium was conducted to understand its impact on student learning outcomes. One evaluation method applied in this study was administering a pre-test and post-test to the fourth-grade students. The pre-test was given before the serious-game medium was used, to measure students’ initial understanding of the exemplary story of Ashab al-Kahf. Meanwhile, the post-test was administered after students went through the learning process using the developed medium, in order to observe the improvement in their mastery of the material.

Data from the pre-test and post-test were then analyzed using the N-Gain (g) formula to determine the extent of the improvement in

students' learning outcomes after using the medium. The N-Gain score is calculated from the difference between the pre-test and post-test scores, which is then categorized according to the N-Gain interpretation table. Through this method, the effectiveness of the guided-inquiry-based serious-game medium in supporting students' overall understanding of the material can be evaluated.

Table 3. N-Gain (g) Classification

Magnitude of N-Gain (g)	Classification
$g > 0.7$	High
$0.3 \leq g \leq 0.7$	Moderate
$g < 0.3$	Low

Results and Discussion

Research Results

Stages of Serious Game Development

At this point in the research process, the researcher had gathered sufficient data to proceed to the next development stage, namely analysis. The results of the analysis of the characteristics and needs of fourth-grade students show that many students find it difficult to grasp the core message of exemplary stories when these are delivered through traditional teacher-led methods. This hinders the development of values and critical-thinking skills in Islamic Religious Education. This finding is consistent with the study by ²³, which revealed that students need more than a textbook for thorough understanding; interactive, context-appropriate learning media are required. In addition, teachers' need for innovative learning media was also revealed through various surveys, including one conducted among teachers themselves. The next step was to evaluate the content standards, basic competencies, and learning indicators within the

²³ A. Nurwidiyanti and P. M. Sari, "Pengembangan media pembelajaran flipbook berbasis literasi sains pada pembelajaran IPA sekolah dasar," *Jurnal Basicedu* 6, no. 4 (2022): 6949–6959.

Islamic Religious Education material, particularly regarding the exemplary story of Ashab al-Kahf. This evaluation covered the mapping of learning objectives, an appropriate pedagogical approach (in this case, guided inquiry), and the potential to integrate exemplary values into a digital learning medium. Based on this analysis, the researcher designed a guided-inquiry-based serious-game learning medium intended to help teachers deliver the material in a more engaging and meaningful way, while encouraging students to actively explore and understand exemplary values in the context of their daily lives ²⁴.

In the second stage, the design stage, the researcher carried out the development of the learning medium by following several important steps. First, the researcher collected and reviewed various reference sources, such as books, websites, and articles related to the exemplary story of Ashab al-Kahf, and linked them to the Basic Competencies (KD) for fourth-grade elementary school students. The researcher then designed the medium's appearance, including the game's cover and background, using various applications to make the medium visually appealing to students. To increase learning interest, the researcher also incorporated a variety of colorful images and illustrations. The medium was then equipped with an opening narrative feature for the story of Ashab al-Kahf, designed to deepen students' understanding. To enrich the interactive experience, the medium was fitted with supporting sound, making the atmosphere and interaction within the serious game feel more realistic and engaging, allowing students to directly experience the atmosphere within the learning medium ²⁵. This design is expected to deliver an interactive and effective learning experience in conveying the material and helping

²⁴ A. N. Damayanti and R. Raharjo, "Validitas flipbook interaktif pada materi sistem pernapasan manusia untuk melatih kemampuan berpikir kritis siswa kelas XI SMA," *Berkala Ilmiah Pendidikan Biologi (BioEdu)* 9, no. 3 (2020): 443–450.

²⁵ [the citation 'Endaryati et al., 2021' has no matching entry in the original reference list]

students understand the values contained in the story of Ashab al-Kahf.

The third stage is the development stage, during which the researcher began compiling usable learning material through a series of planning and production activities. These activities included collecting and organizing content on the exemplary story of Ashab al-Kahf, producing graphic elements such as character illustrations and story backgrounds, and composing the story's narrative to deepen students' understanding. All of these elements were designed interactively in line with the guided-inquiry method so that students could learn actively and independently. During this process, design applications such as Adobe Illustrator were used to create the various visual elements and content, which were then combined into a single serious-game medium within the Unity application. Once the medium had been developed, the next step was to have it validated by material and media experts, to ensure its quality and feasibility before use by students. Revisions and refinements were made based on input from these validators. The validated medium was then distributed to fourth-grade students at SD Negeri 1 Pakisaji as an interactive learning resource intended to improve students' understanding of, and engagement with, the exemplary story of Ashab al-Kahf.

Architecture of the Patrol Game System Based on a Finite State Machine (FSM)

The game developed in this study was designed as a serious-game-based learning medium with interactive, narrative, and exploratory elements. One of the game's key features is the presence of enemies in the form of Roman-soldier characters that move dynamically using a Finite State Machine (FSM) approach. The main character in the game is a young Muslim boy in a green shirt, whose task is to collect coins that appear at random locations (random spawn) within the play area. The game is not time-limited and ends either when all missions have been completed successfully or when the player is caught by an enemy character.

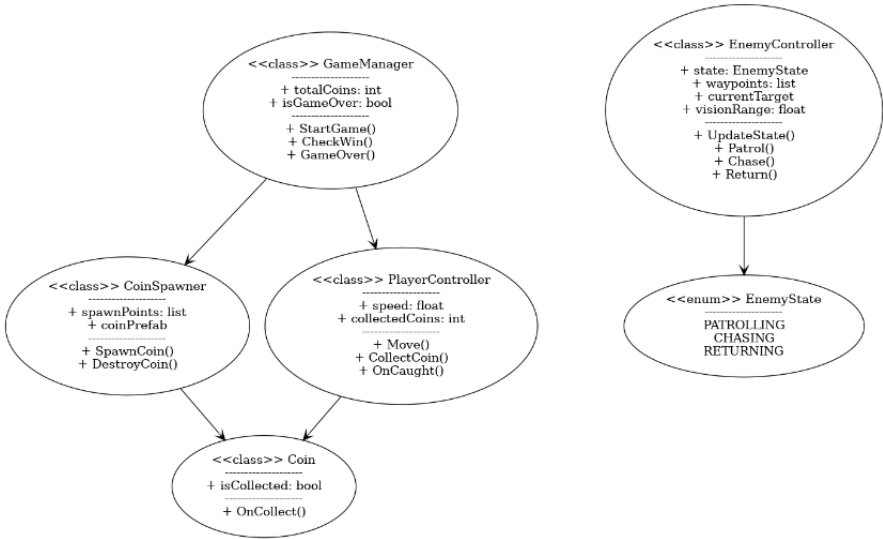


Figure 1. Class Diagram Structure

The following figure shows the class-diagram structure depicting the relationships among the main components of the game system, including player logic, enemies, and the management of coin objects within the game.

FSM Design for the Enemy Character

The enemy character is governed by a Finite State Machine approach consisting of three main states:

Patrolling:

At this stage, the enemy automatically moves along a predetermined path (waypoints). While patrolling, the enemy monitors its surroundings using detection methods such as a vision cone or raycast. If the player enters its field of view, a transition to the next state occurs.

Chasing:

If the enemy detects the player, the FSM transitions to the chasing state. In this state, the enemy increases its speed and attempts to pursue the player until it reaches the limit of its field of view or loses track of the player.

Returning (to the Patrol Path):

When the enemy can no longer see the player or has lost track of them, the FSM transitions to the returning state. The enemy returns to its last patrol point and resumes its original patrol movement.

The transitions between these states follow the simple logic illustrated below:

Patrolling => Chasing => Returning => Patrolling

Game Loop Mechanism

The game is designed without a time limit and has two end conditions:

Win condition: the player successfully collects all the coins randomly scattered at various points within the game environment.

Game-over condition: the player is caught by one of the enemies (Roman soldiers) while carrying out a mission.

With no time limit, the game gives players the freedom to explore the game environment, absorb the narrative of the story, and actively build strategies to avoid enemies.

System Implementation

Software Architecture

The game architecture uses a modular approach based on the Unity Engine, with the following structure:

- GameManager: manages the game's main logic.
- UIManager: handles the menu display, score, and notifications.
- PlayerController: handles player input and interaction.
- EnemyAIController: enemy FSM logic.
- FSMState (abstract class): interface for each state.
- CoinSpawner: generates coins at random.
- AudioManager: handles sound effects and background music.
- DataManager: stores students' scores and learning results.

This system architecture is designed to support an enjoyable and interactive learning experience in which students are challenged to think critically, act carefully, and devise strategies for collecting coins while avoiding enemies. The combination of the guided-inquiry method and this FSM-based game mechanism is expected to increase students’ engagement with, and understanding of, the learning material.

Enemy FSM Pseudocode

```
class EnemyAI:
    state = Patrolling
    function Update():
        if state == Patrolling:
            Patrol()
            if SeePlayer():
                state = Chasing
        elif state == Chasing:
            ChasePlayer()
            if LostPlayer():
                state = Returning
        elif state == Returning:
            ReturnToPath()
            if AtPath():
                state = Patrolling
```

Random Coin Spawner Algorithm

```
for i from 1 to numCoins:
    x = RandomInRange(xMin, xMax)
    y = RandomInRange(yMin, yMax)
    Instantiate(CoinPrefab, x, y)
```

Feasibility of the Learning Medium

The feasibility of the serious-game medium was determined through validation by a media expert. The results of the media expert’s validation are as follows.

Table 4. Media Expert Validation Results

No	Aspect Assessed	Indicator	Score
1	Media engineering	Menu display	4

1	Media engineering	Effectiveness in use	4
1	Media engineering	Usage instructions	4
1	Media engineering	Media attractiveness	4
1	Media engineering	Ease of use	5
2	Appearance	Font type and usage	3
2	Appearance	Text readability and spacing	5
2	Appearance	Presentation across pages	3
2	Appearance	Color harmony and balance of color selection	4
2	Appearance	Suitability of images supporting the material	4
2	Appearance	Design neatness	4
2	Appearance	Balance of image proportions presented	4
Average score	Average score	Average score	4.0

Based on the results, the media expert’s validation produced an average validation score of 4.0, which falls into the highly valid category, within the interval $3.5 \leq Sr \leq 4.0$. Revisions to the medium included improved use of text and typography, a redesigned game cover, and refinements to the narrative model.

Feasibility of the Learning Material

The feasibility of the material was determined through validation by a material expert. The results of the material expert’s validation are as follows.

Table 5. Material Expert Validation Results

No	Aspect Assessed	Indicator	Score
1	Material aspect	Conceptual accuracy	3
1	Material aspect	Currency of the material	3
1	Material aspect	Presentation	4

		sequence	
1	Material aspect	Suitability of examples given	3
2	Suitability with the learning model/method (pedagogical aspect)	Conceptual accuracy; suitability of media use	3
3	Language aspect	Uses correct and easily understandable language	4
4	Fosters critical thinking	Interpretation (understanding the meaning of information and problems)	4
		Analyzing arguments	4
		Focusing questions and one's own opinion	
Average score	Average score	Average score	3.5

Based on the data, the average material-validation score of 3.5 already falls into the highly valid category, within the interval $3.5 \leq Sr < 4.0$, meaning the material for Islamic Religious Education learning can be used without revision. The material on Ashab al-Kahf is therefore suitable for use by the fourth-grade students of SD Negeri 1 Pakisaji, in line with the indicators and objectives that the learning is intended to achieve.

Table 6. Recapitulation of Validators' Assessments

No	Type of Validator	Overall Average Score	Criterion
1	Material expert	3.5	Highly valid
2	Media expert	4.0	Highly valid
	Average	3.7	

Based on Table 6, the recapitulation of the validators' assessments—covering the cover before and after revision, as well as the opening narrative before and after revision—can be seen as follows:

Game Before

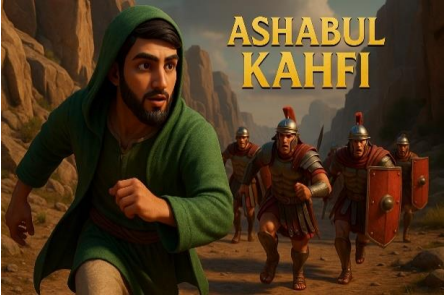


Figure 2. Initial Display and Game Narrative

The next step in development is the implementation, or actualization, stage. At this stage, the serious-game medium that had been designed and tested began to be applied directly in classroom learning. The trial was conducted at SD Negeri 1 Pakisaji, involving fourth-grade students as the study’s subjects. Before learning began, students were given a pre-test to assess their initial understanding of the exemplary story of Ashab al-Kahf. The teacher guided the learning process using the guided-inquiry-based serious-game medium, providing the instructions and information students needed to actively and independently explore the material in line with the flow of the game.



Figure 3. Game Arena

After the learning session ended, students completed a post-test to determine the extent of the improvement in their understanding of, and engagement with, the material after using the medium. The results of the pre-test and post-test were then used as data to analyze the medium’s effectiveness in improving students’ understanding of the material.

Table 7. Recapitulation of Pre-test and Post-test Results

No	Subject	Average Score Obtained	Average Score Obtained
No	Subject	Pre-test Score	Post-test Score

1	18 Grade IV students	47.5	75.4
2	Average N-Gain (g)	0.53	0.53
	Average	53%	53%

The final stage in the development process is the evaluation stage, which aims to assess the effectiveness and feasibility of the developed guided-inquiry-based serious-game medium. The evaluation was carried out through analysis of the pre-test and post-test results given to the fourth-grade students of SD Negeri 1 Pakisaji. Based on calculations using the N-Gain formula, an average score of 0.53 was obtained, which falls into the moderate category (interval $0.3 \leq g \leq 0.7$). This indicates that the learning medium has a fairly good level of effectiveness in improving students' understanding of the exemplary story of Ashab al-Kahf. In addition, the medium's feasibility was also evaluated through validation by material experts, media experts, and student responses. The validation results show that the medium received a score of 3.5 from the material expert and 4.0 from the media expert, with an overall average of 3.75, which falls into the highly valid category. These findings indicate that the developed serious game has met the quality criteria in terms of content, appearance, interactivity, and usefulness, making it suitable for use as teaching material by both teachers and students in Islamic Religious Education learning in the fourth grade of elementary school.

The guided-inquiry-based serious-game medium developed in this study is expected to serve as an engaging and effective learning solution for the exemplary story of Ashab al-Kahf among fourth-grade elementary school students. The medium was designed to create an interactive learning experience and to encourage students' active engagement through the guided-inquiry method. The development of this serious-game medium has the potential to be extended and applied to other learning material appropriate to students' needs. In this study, the evaluation of the medium's feasibility covered three main elements: efficiency, effectiveness, and practicality. From the

standpoint of efficiency, this serious-game medium can be easily accessed and used by both students and teachers. Its effectiveness is reflected in its ability to improve students' understanding of the material while saving time and effort in the learning process. From the standpoint of practicality, the medium offers students a new, enjoyable, and beneficial learning experience that can increase their motivation and engagement in learning²⁶.

Discussion

The application of a guided-inquiry-based serious game in Islamic Religious Education, particularly for the exemplary story of Ashab al-Kahf, not only helps students understand the material more deeply but also plays an important role in developing their critical-thinking skills. The guided-inquiry method within the serious game encourages students to engage actively in the learning process through observation, exploration, reasoning, and drawing conclusions from a relevant and meaningful play experience. Through the game's storyline and challenges, students not only receive information but also learn to solve problems, make choices, and reflect on the values contained within the story. This is in line with the findings of²⁷, which highlight that interactive digital media can serve as an efficient medium for improving understanding and learning effectiveness while reducing the time and effort burden on teachers. In the context of a serious game, these benefits are reinforced by interactive elements, dynamic visuals, and a narrative capable of increasing students' emotional and cognitive engagement. Another study conducted by²⁸ likewise shows that interactive digital learning media, including educational games, can improve critical-thinking skills and support the development of

²⁶ Yunanto and Rochimah, "Systematic Literature Review Terhadap Evaluasi...."

²⁷ E. N. Sitepu, "Media pembelajaran berbasis digital," *Prosiding Pendidikan Dasar* 1, no. 1 (2022): 242–248.

²⁸ Wijaya et al., "Meningkatkan Rasa Nasionalisme Siswa Melalui...", 196–204.

student character traits such as honesty, discipline, collaboration, and self-confidence.

In today's digital era, the millennial and Generation Z cohorts—particularly children born between 1995 and 2010—have attained fairly strong digital literacy and proficiency in using technological devices such as computers and laptops ²⁹. This creates a significant opportunity for education to incorporate technology into the teaching and learning process. The use of digital media such as guided-inquiry-based serious games is one relevant innovation that can adapt to the characteristics of today's students. Serious games can be used not only at school but also at home, under the guidance of teachers and parents, provided students have basic knowledge of operating digital devices. In addition to presenting material interactively, such media are generally equipped with usage instructions that make it easier for students to play independently ³⁰.

The serious-game medium in this study belongs to the multimedia category, as it combines elements such as images, sound, and interactivity centered on narrative and educational challenges. In a learning context, a serious game functions not merely as a teaching aid but also provides students with a deep and valuable learning experience. Like other contextual digital media, a serious game gives students the opportunity to learn at their own pace and in their own way, in line with the principle of self-directed learning. The application of this serious game directly fosters the development of students' critical-thinking skills through guided-inquiry activities that require pattern identification, inquisitiveness, testing of assumptions, and reflection on the messages contained within the exemplary story of Ashab al-Kahf. This learning process also supports interaction among

²⁹ C. Calvo-Porrall and R. Pesqueira-Sanchez, "Generational differences in technology behaviour: comparing millennials and Generation X," *Kybernetes* 49, no. 11 (2020): 2755–2772.

³⁰ R. Agustin, A. Purwarianti, K. Surendro, and I. Suwardi, "Model Konseptual Serious game," *Researchgate. Net* (n.d.).

students through discussion and exploration within the game, which in turn strengthens their character and communication skills ³¹.

A structured development procedure was carried out in this study to ensure that the guided-inquiry-based serious-game medium could efficiently support the development of critical-thinking skills among fourth-grade elementary school students, particularly regarding the exemplary story of Ashab al-Kahf. However, there are several limitations in implementing this medium in real learning contexts. First, the use of this serious game remains focused on Islamic Religious Education with specific material, so its application to other subjects requires further development. Second, this serious-game medium is highly dependent on digital devices such as computers or laptops, meaning its implementation requires adequate school infrastructure support. Access to digital devices and the availability of a stable electricity supply are determining factors for the effectiveness of implementing this medium in an educational setting.

Conclusion

Based on the results of the research and development that have been carried out, the guided-inquiry-based serious-game learning medium is considered to meet the feasibility standard. This is evident from the assessment results of the material expert, who gave a score of 3.5, and the media expert, who gave a score of 4.0, yielding an overall average score of 3.75. This score falls into the highly valid category, indicating that the medium can be applied in the learning process. This validity reflects that the serious game is not only effective in delivering material on the exemplary story of Ashab al-Kahf but also strengthens the development of students' critical-thinking skills and character through the exploratory and reflective approach that characterizes the guided-inquiry method.

During the research process, the control group continued to use the traditional Islamic Religious Education textbook, while the

³¹ Adisusilo, "Perancangan Media Pembelajaran Tematik Sekolah...", 123–132.

experimental group used a guided-inquiry-based serious-game learning medium. The findings indicate that the improvement in students' critical-thinking skills was more pronounced in the experimental group. This suggests that the application of a guided-inquiry-based serious game can provide a more interactive and meaningful learning experience compared with conventional learning methods. This serious-game medium combines visual, narrative, and challenge-based elements that are not only aesthetically engaging but also contextual and relevant to students' daily lives. These elements encourage students to explore, connect the values of the exemplary story to their own lives, and naturally hone their critical-thinking skills through an educational game.

References

- Adisusilo, A. K. "Perancangan Media Pembelajaran Tematik Sekolah Dasar Berbasis Serious Game." *Matrix: Jurnal Manajemen Teknologi Dan Informatika* 10, no. 3 (2020): 123–132.
- Agustin, R., A. Purwarianti, K. Surendro, and I. Suwardi. "Model Konseptual Serious game." *Researchgate. Net* (n.d.).
- Amalia, S. H., A. Purwanto, and E. Risdianto. "Pengembangan Media Pembelajaran Game Edukasi Fisika (GEMIKA) Berbantuan Wordwall Untuk Meningkatkan Motivasi Belajar Siswa SMA." *Jurnal Penelitian Pembelajaran Fisika* 15, no. 2 (2024): 222–232.
- Arianti, A. "Urgensi lingkungan belajar yang kondusif dalam mendorong siswa belajar aktif." *Didaktika: Jurnal Kependidikan* 11, no. 1 (2017): 41–62.
- Asela, S., U. H. Salsabila, N. H. P. Lestari, A. Sihati, and A. R. Pertiwi. "Peran media interaktif dalam pembelajaran PAI bagi gaya belajar siswa visual." *Jurnal Inovasi Penelitian* 1, no. 7 (2020): 1297–1304.
- Calvo-Porrà, C., and R. Pesqueira-Sánchez. "Generational differences in technology behaviour: comparing millennials and Generation X." *Kybernetes* 49, no. 11 (2020): 2755–2772.

- Damayanti, A. N., and R. Raharjo. "Validitas flipbook interaktif pada materi sistem pernapasan manusia untuk melatih kemampuan berpikir kritis siswa kelas XI SMA." *Berkala Ilmiah Pendidikan Biologi (BioEdu)* 9, no. 3 (2020): 443–450.
- Fahrul, A. M. "Pengertian Game Online dan Dampaknya." *Jakarta Media Anak* (2010).
- Hapsari, M. J. "Upaya meningkatkan self-confidence siswa dalam pembelajaran matematika melalui model inkuiri terbimbing." *Prosiding Seminar Nasional Matematika Dan Pendidikan Matematika UNY* 30, no. 1 (2011): 337–345.
- Hidayatno, A., A. R. Destyanto, and M. R. N. Iman. *Bermain untuk Belajar: Merancang Permainan Sebagai Media Pembelajaran yang Efektif*. Penerbit LeutikaPrio (2018).
- Lovisia, E. "Pengaruh model pembelajaran inkuiri terbimbing terhadap hasil belajar." *SPEJ (Science and Physic Education Journal)* 2, no. 1 (2018): 1–10.
- Nurwidiyanti, A., and P. M. Sari. "Pengembangan media pembelajaran flipbook berbasis literasi sains pada pembelajaran IPA sekolah dasar." *Jurnal Basicedu* 6, no. 4 (2022): 6949–6959.
- Prasasti, R. D., and N. Anas. "Pengembangan media digital berbasis flipbook untuk meningkatkan kemampuan berpikir kritis pada peserta didik." *Munaddhomah: Jurnal Manajemen Pendidikan Islam* 4, no. 3 (2023): 694–705.
- Pratama, C. B. "Pengembangan Media Game Bertema Serious Game Sebagai Pembelajaran Berbasis Ice Breaking." *Seminar Nasional Teknologi & Sains* 3, no. 1 (2024): 139–144.
- Pratiwi, A., F. Hikmah, A. A. Adiansha, and S. Suciati. "Analisis penerapan metode games education dalam meningkatkan motivasi belajar siswa sekolah dasar." *JagoMIPA: Jurnal Pendidikan Matematika Dan IPA* 1, no. 1 (2021): 36–43.

- Rohmah, S., and I. M. Tegeh. "Multimedia Interaktif Untuk Meningkatkan Minat dan Hasil Belajar PAI." *Jurnal Edutech Undiksha* 10, no. 2 (2022): 215–224.
- Saleh, M. S., S. Syahrudin, M. S. Saleh, I. Azis, and S. Sahabuddin. *Media pembelajaran* (2023).
- Sitepu, E. N. "Media pembelajaran berbasis digital." *Prosiding Pendidikan Dasar* 1, no. 1 (2022): 242–248.
- Sugiyono, S. "Metode penelitian kuantitatif dan kualitatif dan R&D." *Alfabeta Bandung* 14 (2010).
- Tiana, A., A. D. Sagita Krissandi, and M. Sarwi. "Peningkatan motivasi dan hasil belajar siswa melalui media game quizizz pada mata pelajaran matematika." *Jurnal Pendidikan Indonesia* 2, no. 6 (2021): 943–952.
- Utomo, F. T. S. "Inovasi Media Pembelajaran Interaktif Untuk Meningkatkan Efektivitas Pembelajaran Era Digital Di Sekolah Dasar." *Pendas: Jurnal Ilmiah Pendidikan Dasar* 8, no. 2 (2023): 3635–3645.
- Vega Vitianingsih, A. "Game edukasi sebagai media pembelajaran pendidikan anak usia dini." *Inform* 1, no. 1 (2016): 25–32.
- Wartini, N. W. "Implementasi model pembelajaran inkuiri terbimbing untuk meningkatkan motivasi belajar dan kemampuan berpikir kritis." *Journal of Education Action Research* 5, no. 1 (2021): 126–132.
- Wijaya, A. B., S. Suliswaningsih, and A. D. Pritama. "Meningkatkan Rasa Nasionalisme Siswa Melalui Game Base Learning." *Matrik: Jurnal Manajemen, Teknik Informatika Dan Rekayasa Komputer* 19, no. 1 (2019): 196–204.
- Windawati, R., and H. D. Koeswanti. "Pengembangan Game Edukasi Berbasis Android untuk Meningkatkan hasil Belajar Siswa di Sekolah Dasar." *Jurnal Basicedu* 5, no. 2 (2021): 1027–1038.

- Yunanto, A. A., and S. Rochimah. "Systematic Literature Review Terhadap Evaluasi Perangkat Lunak Tentang Serious Game." *Jurnal Informatika* 4, no. 1 (2017).
- Yunita, N. P., and R. E. Indrajit. *GAMIFICATION: Membuat Belajar Seasyik Bermain Game*. Penerbit Andi (2022).