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Implementation of Educational Game System Using MDLC with Adobe Animate Application

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Abstract: Digital gaming has transformed educational practices across Indonesia, creating new pathways for curriculum delivery through interactive entertainment. Educational games now serve as effective learning tools that capture student attention while building essential skills. The research develops and evaluates a multi-level educational puzzle game using Adobe Animate 2022, targeting cognitive skill enhancement and problem-solving abilities across different age groups. Development followed the Multimedia Development Life Cycle (MDLC) approach through six phases: conceptualization, design planning, resource gathering, system building, testing procedures, and final deployment. The puzzle application includes three difficulty levels with varying complexity parameters. Adobe Animate 2022 handled vector graphics creation, interactive programming, and multi-platform publishing. User evaluation involved testing across target demographics to assess usability and learning effectiveness. The finished application successfully demonstrates structured game development using MDLC principles. Testing showed positive user responses with balanced difficulty progression and completion rates that indicate effective entertainment-education integration. The development process provided organized workflows that supported quality control and user satisfaction goals. Adobe Animate 2022 proved capable for educational game creation, enabling smooth asset management and publishing operations. The study establishes a reproducible model for future educational gaming projects while validating game-based learning methods in Indonesian educational settings. Findings suggest that systematic development approaches produce superior educational outcomes compared to informal development practices.

Keywords: Interactive Learning; Educational Gaming; Adobe Animate; Multimedia Development Life Cycle; Cognitive Skills Development.

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1. Introduction

The digital transformation of educational practices has fundamentally altered how learning occurs across various academic disciplines and age groups. Educational technology integration represents a significant shift from traditional pedagogical approaches, where interactive media serves as both engagement tool and knowledge delivery mechanism. Games, particularly puzzle-based applications, have emerged as powerful educational instruments that combine entertainment value with structured learning objectives [1]. The growing adoption of game-based learning methodologies reflects educators' recognition that interactive experiences can enhance cognitive development and problem-solving capabilities more effectively than conventional instructional methods.

Indonesia educational landscape has witnessed substantial changes in recent years, with digital learning platforms becoming increasingly prevalent across educational institutions. The COVID-19 pandemic accelerated the adoption of technology-enhanced learning solutions, forcing educators to explore alternative delivery methods for curriculum content [2]. Educational games have gained particular attention because they address multiple learning challenges simultaneously: maintaining student engagement, providing immediate feedback, and accommodating different learning styles within single applications. Research indicates that puzzle games specifically target cognitive functions such as spatial reasoning, pattern recognition, and logical thinking skills that transfer to academic performance across multiple subjects.

The development of educational games requires systematic approaches that ensure both technical functionality and pedagogical effectiveness. The Multimedia Development Life Cycle (MDLC) methodology has proven particularly valuable for creating educational applications because it provides structured frameworks for managing complex development processes [3]. MDLC encompasses six distinct phases: concept development, design planning, material collection, assembly implementation, testing procedures, and distribution deployment. Each phase includes specific deliverables and quality checkpoints that help development teams maintain focus on educational objectives while managing technical requirements. Adobe Animate has become a preferred development platform for educational game creation due to its vector graphics capabilities, cross-platform publishing options, and interactive scripting features. The software supports multiple output formats, enabling developers to create applications that function across desktop computers, tablets, and mobile devices without requiring separate development cycles for each platform. Previous research has demonstrated successful implementation of Adobe Animate for various educational applications, including cultural awareness games and language learning tools [4]. The platform's timeline-based animation system allows developers to create engaging visual experiences while maintaining reasonable file sizes for web distribution.

Puzzle games offer unique educational advantages because they require active problem-solving rather than passive information consumption. Players must analyze situations, develop strategies, and test solutions through trial-and-error processes that mirror scientific thinking methods. Educational puzzle games can be designed with progressive difficulty levels that adapt to individual learning paces, providing appropriate challenges without causing frustration or boredom. Research suggests that well-designed puzzle games improve spatial intelligence, working memory capacity, and executive function skills that benefit academic performance across multiple domains. The evaluation of educational games requires careful consideration of both usability factors and learning outcomes. Traditional assessment methods may not capture the full range of benefits that game-based learning provides, particularly regarding engagement levels and motivation sustainability. Likert scale questionnaires have proven effective for measuring user satisfaction and perceived learning effectiveness in educational technology applications [5]. These instruments allow researchers to quantify subjective experiences while maintaining statistical validity for comparative analysis. Mobile learning applications have gained significant traction in educational settings because they provide flexibility and accessibility that traditional classroom environments cannot match [6]. Students can access educational content at their own pace and revisit challenging concepts as needed, leading to improved learning outcomes and higher completion rates. The portability of mobile devices also enables learning to occur in various settings, extending educational opportunities beyond formal classroom boundaries.

System development methodologies play crucial roles in ensuring educational applications meet both technical specifications and user requirements. Information system design principles, including user interface optimization and database management, directly impact educational software effectiveness [7]. Proper system architecture ensures applications can handle multiple simultaneous users while maintaining responsive performance and data integrity. The integration of monitoring capabilities within educational applications allows instructors to track student progress and identify areas requiring additional support [8]. Real-time data collection enables adaptive learning pathways that adjust difficulty levels based on individual performance patterns, maximizing educational effectiveness for diverse learner populations.

Augmented reality and other emerging technologies continue to expand possibilities for educational game development, creating immersive experiences that were previously impossible [9]. These technological

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advances suggest that educational gaming will continue evolving, offering increasingly sophisticated tools for knowledge transfer and skill development. Given the growing importance of educational games and the proven effectiveness of systematic development approaches, there exists a clear need for research that documents successful implementation strategies while providing replicable frameworks for future projects. The current study addresses these needs by developing and evaluating a multi-level educational puzzle game using established development methodologies and assessment techniques.

2. Related Work

2.1 Puzzle Games

Puzzle games originate from the English term meaning challenge or disassembly. These games represent simple media played through disassembling and reassembling activities. Players engage with puzzle games to solve specific problems, with most challenges involving logic problems that often include time constraints. The fundamental design centers on disassembling and reassembling parts to reach solutions. Puzzle games target particular challenges, frequently incorporating logic problems with constraints like time limits to increase engagement and difficulty levels [10]. The format supports cognitive training by requiring players to actively use logic and reasoning skills, transforming puzzle games from mere entertainment into valuable educational resources [12].

2.2 Educational Games

Educational games are specifically designed to teach users particular learning concepts, promote understanding, and guide skill development while motivating players to engage with content. These games uniquely engineer specific knowledge transfer, concept development, and skill training tools while encouraging motivation throughout the learning process [11][1]. Educational game criteria include features that facilitate engagement, interactivity, and alignment with learning objectives. Educational puzzle games, as examined by Haka *et al*. (2021), utilize technological tools positively, creating interesting atmospheres for learning subjects like biology [10]. Research by Zusanty *et al*. (2022) reveals that puzzle media positively influences cognitive development and language skills in young learners [12]. Educational games must meet several criteria:

1) Overall Value
   Game value focuses on design and duration. Applications require attractive and interactive designs. Timer features determine duration parameters.
2) Usability
   Easy access and use remain crucial for game developers. Applications need user-friendly interfaces allowing simple access.
3) Accuracy
   Accuracy measures how successfully game models or images translate into experiments or designs. Application designs must match game models from planning stages.
4) Appropriateness
   Content and design must adapt well to user needs. Applications should provide necessary menus and features helping users understand usage.

Research shows that educational games, particularly those using puzzle features, foster critical thinking and problem-solving skills by engaging students through interactive challenges [1]. Faaiqoh and Ratnaningrum (2024) [1] demonstrated that implementing puzzle educational games in science subjects significantly enhances student interest and material understanding, encouraging active participation in educational journeys. Lestari *et al*. (2019) observed that games combining adventure and puzzle features create more interactive and stimulating learning environments [11].

2.3 Adobe Animate in Educational Game Development

Educational game systems have gained popularity as dynamic tools for enhancing student engagement and learning outcomes. Adobe Animate integration within the Multimedia Development Life Cycle (MDLC) framework has enabled new approaches in educational content delivery [3]. The MDLC framework provides strategic foundations for developing educational media, including animated learning games. Huda and Maulana (2022) examined animation in educational media development, showing that structured creation phases significantly influence educational outcomes [18]. Baihaki *et al*. (2022) [15] and Akmal *et al*. (2022) demonstrated that interactive and animated content enhances students' understanding of mathematical concepts and practical skills [14]. Regarding Adobe Animate applications, Ferdiani *et al*. (2023) examined its effectiveness in developing problem-based learning video animations [17]. Students actively engage with educational materials through innovative approaches, fostering better understanding and retention. Thomas

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et al. (2024) emphasized interactive multimedia's role in increasing student participation and improving instructional quality [23]. Their research shows that integrating gamification features like quizzes and interactive tasks can significantly boost student engagement levels. Additional studies demonstrate Adobe Animate's effectiveness across various educational settings. Sianturi and Damanik (2022) showed that interactive media in chemistry education enhances learning outcomes for hydrocarbon materials [28]. Prasetyo *et al*. (2022) emphasized how animated educational content focusing on biological processes accommodates varied learning styles [26], ultimately improving academic performance among learners. These tailored approaches align with contemporary pedagogical theories advocating differentiated instruction based on learner needs. Educational games research reveals multiple benefits. Sholikhah and Ratu (2022) conducted research on algebraic operations, showing how game-based learning effectively builds conceptual understanding [27]. Abdullah and Yunianta (2018) validated these findings through developing educational games addressing fundamental mathematics concepts in trigonometry, demonstrating positive correlations between game-based learning and student engagement [13]. Educational games built with tools like Adobe Animate represent growing trends within educational technology. These games leverage interactive media potential to foster engaging learning environments, as evidenced by Dhanil and Mufit (2021) in physics education and Nurjanah *et al*. (2021) in health education settings [16][19]. Their research supports the idea that well-structured interactive multimedia facilitates deeper understanding and engagement with educational content.

2.4 System Development and Evaluation

System development methodologies ensure educational applications meet technical specifications and user requirements. Information system design principles, including user interface optimization and database management, directly impact educational software effectiveness [7]. Monitoring capabilities within educational applications allow instructors to track student progress and identify areas requiring additional support [8]. Educational game evaluation requires careful consideration of usability factors and learning outcomes. Likert scale questionnaires prove effective for measuring user satisfaction and perceived learning effectiveness in educational technology applications [5]. These instruments allow researchers to quantify subjective experiences while maintaining statistical validity for comparative analysis. Mobile learning applications have gained significant traction in educational settings by providing flexibility and accessibility that traditional classroom environments cannot match [6]. Mobile learning interface design requires careful consideration of emotional aspects to ensure optimal user experience [31], with research indicating that emotionally-aware interface design significantly impacts learning effectiveness. Integrating puzzles within educational games represents powerful tools for enhancing learners' cognitive and problem-solving capabilities. Educational game systems using Adobe Animate under the MDLC framework offer educational institutions robust methodologies for enhancing learning experiences. Research consistently reveals that through structured development processes and interactive content, educators can create engaging and effective educational environments that accommodate diverse learner needs [10][11][1].

3. Research Method

This research utilized Adobe Animate 2022 as the primary development tool for creating educational puzzle games. Adobe Animate 2022 represents a modern multimedia authoring platform that enables developers to create interactive animations and educational content effectively. The study applied the Multimedia Development Life Cycle (MDLC) methodology to ensure systematic and structured game development. The Multimedia Development Life Cycle (MDLC) serves as the foundational framework for developing interactive multimedia applications, particularly educational games. The methodology encompasses six sequential stages: Concept, Design, Material Collecting, Assembly, Testing, and Distribution. When applied to puzzle game creation using Adobe Animate 2022, MDLC provides a structured approach that ensures careful consideration and execution of each development aspect. The MDLC methodology was selected due to its systematic nature that facilitates clear and logical developmental steps. Mustika *et al*. (2018) demonstrated that the MDLC method proves particularly effective in interactive learning environments, providing structured stages that developers can navigate systematically [22]. The approach facilitates game conceptualization while streamlining the design process, ensuring educational content remains engaging and appropriate for target audiences.

Adobe Animate 2022 functions effectively within the MDLC framework, enabling developers to create interactive animations and multimedia materials essential for modern puzzle games. Research indicates that utilizing multimedia design tools simplifies the assembly phase of MDLC, allowing quick integration of visual assets and interactivity features that enhance user experience [23][24]. Salim and Maulana (2023) emphasized that combining the MDLC method with appropriate software applications leads to improved outcomes in

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educational game development [24]. Adobe Animate proves particularly valuable for creating visually appealing and engaging interfaces that align with MDLC design phase objectives. The platform's capabilities enable sophisticated animations and interactions that make puzzle-related learning materials more enjoyable and effective. Kurniawan *et al.* (2021) reported similar advantages when using multimedia tools with the MDLC approach, noting that software selection significantly influences output quality [20]. Testing represents another critical MDLC phase, ensuring puzzle games function as intended and meet educational goals. Lestari and Huriah (2022) assert that thorough testing within the MDLC framework helps identify usability issues, enhancing learning experiences [21]. Integrating testing phases with Adobe Animate features allows developers to refine games, ensuring they remain both entertaining and educational while achieving desired learning outcomes. The distribution phase proves vital for reaching intended audiences. Adobe Animate enables developers to export games to various formats suitable for multiple platforms, including web-based applications and mobile devices. Such flexibility ensures educational puzzle games can be disseminated widely, maximizing their educational impact. Sukmawati *et al.* (2023) noted that multimedia application adaptability across various settings [25], including educational environments, demonstrates the value of MDLC methodology in modern software development.

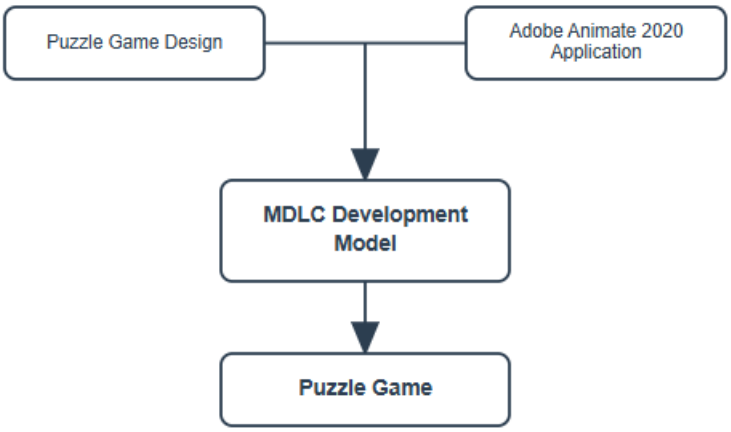

Figure 1. Framework of Thought

3.1 Multimedia Development Life Cycle (MDLC)

The study develops engaging and efficient puzzle games using Adobe Animate 2022. The research employs the Multimedia Development Life Cycle (MDLC) methodology, which encompasses six sequential stages: concept, design, material collecting, assembly, testing, and distribution.

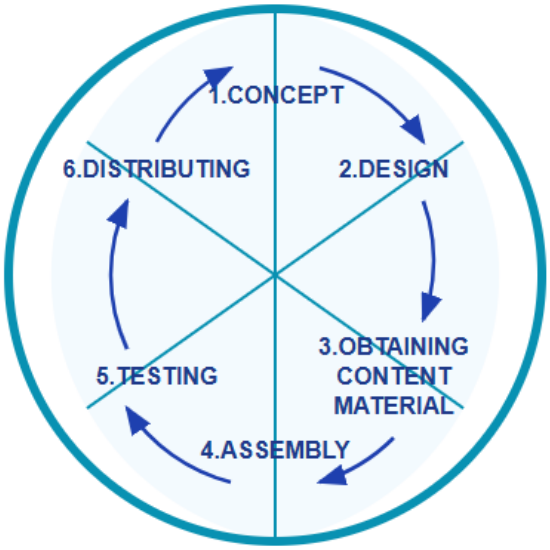

Figure 2. Multimedia Development Life Cycle Diagram

1) Concept (Conceptualization Stage)
The initial MDLC stage determines objectives and target users for interactive learning media. The stage requires understanding user demographics and media creation purposes to ensure efficient and appropriate implementation.

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2) Design
The design stage outlines project execution methods and creation processes using Adobe Animate 2022. The phase involves creating visual displays, navigation systems, and media design processes. Recent studies demonstrate that systematic design approaches in Adobe Animate applications significantly enhance educational outcomes [29][28].
3) Material Collecting
The stage involves gathering all necessary materials for puzzle game creation. Since the game utilizes computer-based development, required materials primarily consist of multimedia files including audio and visual assets that will be integrated into playable game formats.
4) Assembly (Manufacturing)
All multimedia objects and materials are assembled during the stage. Project creation follows design stage specifications including storyboards, flowcharts, and navigation structures. Adobe Animate 2022 serves as the primary assembly and organization tool. Prasetyo *et al*. (2022) and Sholikhah and Ratu (2022) demonstrated that Adobe Animate's assembly capabilities effectively support educational content development across various subjects [26][27].
5) Testing
Following puzzle game completion, testing ensures proper functionality and appropriateness before public release. Testing phases verify game mechanics, educational effectiveness, and user experience quality.
6) Distribution
The final MDLC stage involves duplicating and distributing puzzle games with satisfactory feasibility values to target users for collaborative gameplay experiences.

3.2 Design Principles

The puzzle game development incorporates fundamental design principles to ensure visual effectiveness and user engagement. Such principles include balance to avoid visual irregularities, focal points to establish attention centers, and visual hierarchy to organize parts according to importance levels. Rhythm creates pattern consistency through design variations, while unity ensures harmonic relationships between all design parts.

1) Balance/Equilibrium
Balance represents a principle in design that avoids an unbalanced appearance in certain areas or sides of the space where visual parts are placed.
2) Focal Point
The focal point becomes the center of attention, a part that proves necessary in design composition to highlight that section as something important and to make it the main visual object.
3) Visual Hierarchy
Visual hierarchy organizes all parts in relation to visual attention and other design levels that are directly related to the focal point.
4) Rhythm
Rhythm can be described as a pattern that is designed by creating or repeating design variations through consideration of available space and by designing a feeling of moving from one part to another, either through color, size or value that is displayed simultaneously in repetitions.
5) Unity
Unity represents a principle that is based on the harmony of all parts designed in terms of their form or their relationship to the underlying idea. Unity is needed in graphic work to support each other between one part and another so that focus is obtained.
6) Proportion
Proportion can be expressed as a comparison between one object to another object. Proportion is not a scale, but proportion relates closely to other objects that can be adjusted to existing objects.
7) Simplicity
The principle of simplicity can be included in visual design in the sense that adding another object would create chaos in the design, but sometimes reducing design objects feels like something is missing. Simple does not have to mean minimal, but can be interpreted as fitting, meaning not more or not less - the appropriate term is proportional.
8) Contrast
In design, contrast proves necessary to create a non-monotonous impression so that there is contrast in every design composition. Contrast should be applied as needed because if excessive, it can create irregularity so that it does not create design harmony.

Such principles align with contemporary multimedia design standards and support educational game effectiveness [31]. The MDLC methodology, combined with Adobe Animate 2022's capabilities, creates a robust

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framework for developing interactive educational puzzle games. The systematic approach ensures consideration and execution of all development aspects, resulting in effective educational tools that enhance learning experiences for target users.

4. Result and Discussion

4.1 Results

The interactive puzzle game begins with an opening screen that displays the game title along with a play button for navigation to the first level. The opening screen interface features a clean design focused on user accessibility.

Figure 3. Opening screen

Figure 4. Puzzle level 1 view

The main game consists of three progressive difficulty levels, each offering unique challenges for players. Level 1 presents the initial puzzle experience where players encounter a random button to start the game, a reference image of the target puzzle, and a home button for returning to the main screen (Figure 3). During gameplay, players arrange puzzle pieces within designated areas (Figure 4).

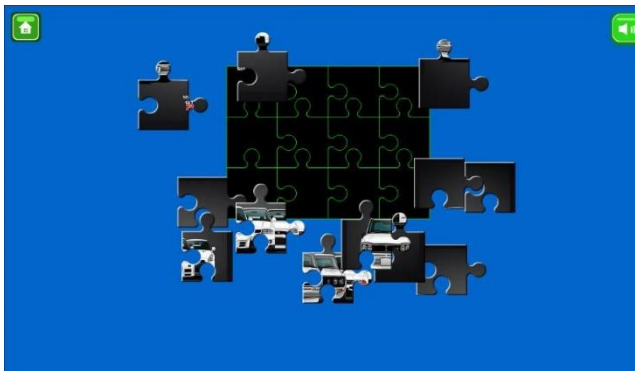

Figure 5. Display of assembling puzzle level 1

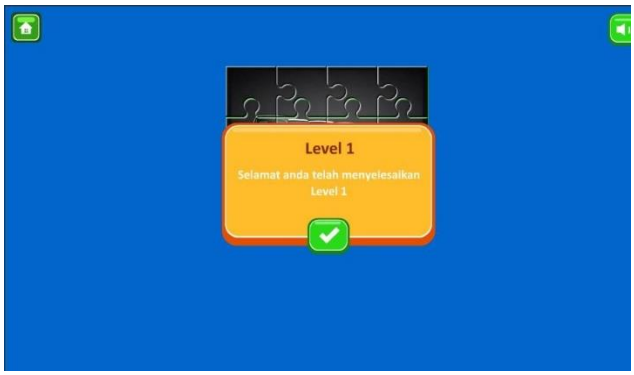

Figure 6. View of the completed puzzle

Upon successful completion, a notification popup appears directing players to the next level (Figure 5). Level 2 increases the complexity while maintaining the same interface structure (Figure 6).

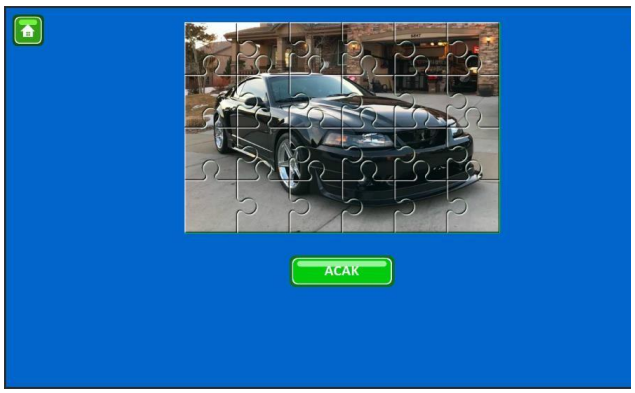

Figure 7. Puzzle level 2 view

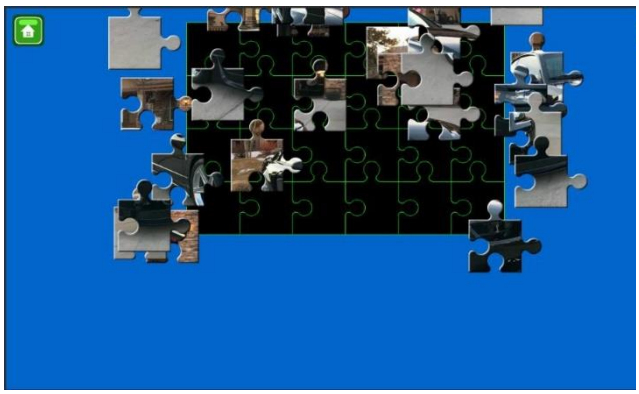

Figure 8. Display of assembling puzzle level 2

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The puzzle assembly process continues at the intermediate difficulty level (Figure 7). The final challenge appears in Level 3, where players face the highest difficulty setting (Figure 8).

Figure 9. Puzzle level 3 view

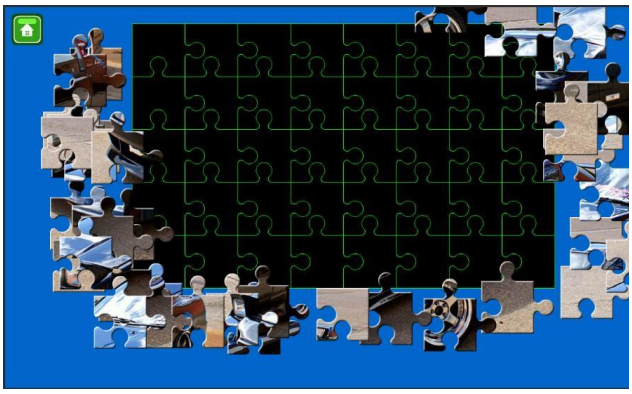

Figure 10. Display of assembling puzzle level 3

Players work through the assembly process for the most challenging puzzles (Figure 9). When players successfully complete all three levels, the system displays a congratulatory screen acknowledging their achievement (Figure 10).

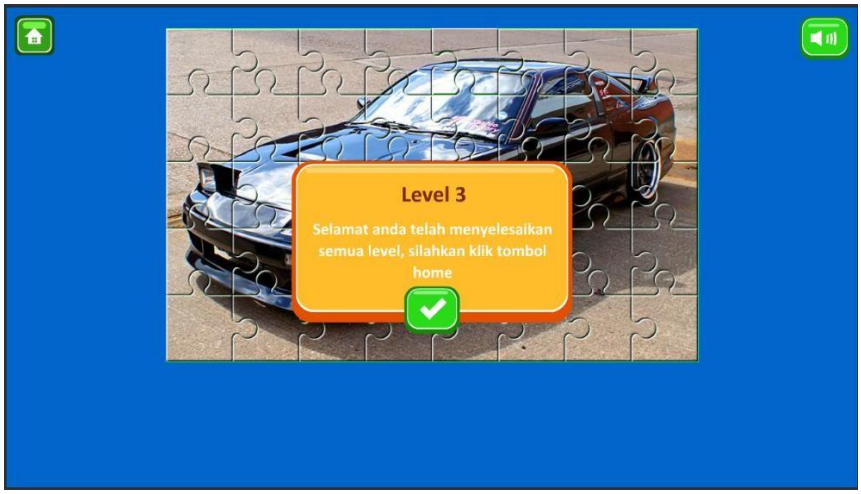

Figure 11. Display when successfully completing all levels

The progression through all levels provides a satisfying gameplay experience with increasing challenges that maintain player engagement throughout the entire game (Figure 11). The development process followed the Multimedia Development Life Cycle (MDLC) methodology across six distinct phases. The Concept phase established the game's purpose as interactive entertainment suitable for all age groups, defining users as a broad demographic spanning from children to adults. The Design phase utilized Adobe Animate Creative Cloud to create use case diagrams, opening page layouts, and puzzle interface designs. Material Collection involved gathering background images for the opening screen, puzzle images featuring car graphics, and button graphics for navigation. The Assembly phase integrated all multimedia materials using Adobe Animate Creative Cloud, implementing the game logic based on the predetermined flowchart design. Testing verified functionality across team members' computers, confirming operational ease and error-free performance. Distribution prepared the final product for user deployment after achieving satisfactory quality standards.

4.2 Discussion

The interface design demonstrates effective user experience principles through intuitive navigation and clear visual hierarchy. The opening screen's simplicity facilitates immediate user engagement, while consistent button placement across levels maintains familiar interaction patterns. The three-level structure creates natural progression that aligns with established game design practices, where difficulty increases gradually to sustain player interest without causing frustration [10]. Research by Faaiqoh & Ratnaningrum (2024) shows that puzzle-based educational games effectively enhance learning outcomes when designed with progressive difficulty levels [1]. The MDLC methodology proved highly effective for developing multimedia educational games. Each phase contributed specific value to the overall development process, creating a structured approach that minimized development risks and ensured quality outcomes [22]. The Concept phase provided

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clear direction by establishing target audiences and objectives, preventing scope creep during later development stages. The systematic approach aligns with findings from Riswandari *et al.*, (2021) who successfully implemented MDLC for e-learning development using Adobe Animate Creative Cloud [3].

Design phase activities generated essential blueprints that guided subsequent development work. Use case diagrams and flowcharts served as communication tools between team members, ensuring shared understanding of system requirements and user interactions [4]. Material Collection prevented production delays by securing all necessary assets before assembly began, while the systematic approach reduced the likelihood of missing critical resources. The structured methodology follows best practices established in multimedia development research [23]. Adobe Animate Creative Cloud proved suitable for assembly requirements, enabling seamless integration of visual and interactive features. The software's capabilities matched project needs, allowing developers to implement planned features without technical limitations. The choice aligns with successful implementations documented by Prasetyo *et al.* (2022) and Sholikhah & Ratu (2022), who utilized Adobe Animate for educational content development [26][27]. Testing phase activities validated both functionality and usability, confirming that the game operates correctly across different computing environments, similar to validation approaches used by Sianturi & Damanik [28]. The current implementation offers several strengths including straightforward interface design, logical level progression, systematic development approach, and verified cross-platform compatibility. However, certain limitations exist such as restricted level quantity, minimal puzzle variety, absence of scoring systems, and lack of progress saving features. These limitations mirror challenges identified in similar educational game development projects [13][15].

Future development could address these limitations through expanded level collections, diverse puzzle types, achievement systems, and enhanced user features. The current foundation provides a solid base for scaling to larger projects with additional functionality. User testing with broader demographics would provide valuable feedback for interface refinements and feature prioritization, following methodologies established by Thomas *et al.* for measuring student engagement in interactive media [29]. The MDLC approach demonstrates particular value for educational game development, offering structured methodology that balances creative freedom with systematic quality assurance. Teams developing similar projects could benefit from adopting comparable approaches, adapting specific techniques to match their unique requirements and constraints [14][16]. The successful implementation validates MDLC as a viable framework for multimedia educational content creation, supporting findings from multiple studies that emphasize the effectiveness of systematic development approaches in educational technology [17][18]. The interface design considerations also reflect principles established in mobile learning research, where emotional aspects and user experience significantly impact learning effectiveness [31][32]. The game's design philosophy aligns with successful mobile application development practices documented in related educational technology implementations [2][6].

5. Conclusion

The development of the puzzle game successfully demonstrates the practical application of multimedia design principles in educational gaming. The implementation serves as an effective learning tool that can enhance student engagement and motivation in academic environments. The game's design specifically introduces students to the Multimedia course within the Informatics Engineering study program at the University of Palangka Raya, providing hands-on experience with interactive media development. The MDLC methodology proved to be a reliable framework for systematic game development, ensuring quality outcomes through structured phases from concept to testing. Adobe Animate Creative Cloud emerged as a suitable platform for educational game creation, offering the necessary tools for integrating visual and interactive features effectively. The three-level progression system successfully maintains player interest while gradually increasing difficulty, following established principles in educational game design.

The project establishes a foundation for future educational game development initiatives. Students can utilize the design principles and development methodology as a reference for creating more diverse gaming applications with enhanced features and varied interaction patterns. The systematic approach documented in the development process can guide similar projects, adapting the methodology to different educational objectives and technical requirements. Future enhancements could include expanded level collections, diverse puzzle mechanics, scoring systems, and progress tracking capabilities. The current implementation provides a solid base for scaling to more sophisticated educational gaming projects that incorporate advanced multimedia techniques and broader pedagogical approaches. The successful completion of the project validates the effectiveness of combining structured development methodologies with appropriate software tools in creating meaningful educational experiences.

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