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Improving Collaboration and Informatics Learning Outcomes through Flash Cards and the Joyful Learning Approach

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Abstract

The low level of student collaboration in Informatics learning presents a serious challenge that can hinder the achievement of optimal cognitive learning outcomes. A lack of cooperation causes students to struggle with sharing ideas, solving problems together, and developing a deep conceptual understanding. To address this issue, a Flash Card learning medium based on Augmented Reality (AR) was developed and integrated with a Joyful Learning approach. The aim is to create an enjoyable and interactive learning environment while enhancing student collaboration. This study employed a Research and Development (R&D) method using the ADDIE model in the development process. The resulting media was evaluated for feasibility and effectiveness through observations and learning outcome tests. Collaboration aspects were assessed using indicators such as communication, task distribution, decision-making consensus, and active engagement. The findings revealed that the AR-based Flash Card media significantly improved the learning outcomes of seventh-grade students in the Computer Systems topic, as evidenced by 93.3% of students scoring above the minimum passing grade, with an average score of 84.6. Additionally, the collaboration level reached 87.6%, categorized as "very good." With interactive 3D visualizations and an enjoyable learning atmosphere, this media effectively supports Informatics learning in both cognitive and socio-affective aspects.

Keywords

Flash Card, Joyful Learning, Learning Outcomes, Informatics, Augmented Reality.

1. Introduction

Informatics learning requires students not only to master technical concepts but also to develop effective collaboration skills. Collaboration among students is a crucial aspect of the learning process, as it can enhance conceptual understanding through discussions, idea sharing, and teamwork in solving problems. However, various studies have shown that students' collaborative abilities in Informatics learning are still relatively low (Warsah et al., 2021). This lack of collaboration negatively impacts the effectiveness of learning, particularly in improving students' cognitive learning outcomes (Susanti et al., 2020). The issue of low student collaboration not only hinders social interaction but also reduces learning motivation and critical thinking skills. This is supported by a study conducted by Le et al. (2018), which found that students who engage in effective collaboration tend to achieve better learning outcomes than those who work individually. Therefore, there is a need for innovative learning media that can enhance both collaboration and student achievement. One promising innovation is the use of Augmented Reality (AR)-based flash cards. AR technology enables the presentation of learning materials interactively and engagingly, thereby increasing student engagement in the learning process (Hariyono, 2023; Aldeeb et al., 2024). AR flash cards not only present information visually but also provide an enjoyable learning experience and help students better understand abstract Informatics concepts. As a result, this media has the potential to foster student collaboration through interactive and communicative learning activities (Wulandari et al., 2023).

In addition to technology, the learning approach also plays a crucial role in enhancing learning effectiveness. The Joyful Learning approach, which emphasizes a fun and motivating learning environment, has been proven to increase student participation and collaboration (Sari & Putri, 2021; Mokhtar et al., 2023). A previous study by Wahyuni et al. (2024) showed that the application of Joyful Learning can significantly improve students' cognitive learning outcomes. This approach encourages students to actively interact and collaborate in a positive atmosphere, thereby strengthening the learning process. Furthermore, research by Mokmin et al. (2024) confirmed that the use of AR-based learning media, when combined with an enjoyable learning approach, can significantly enhance students' collaboration skills and academic performance. Augmented Reality (AR) itself has been shown to improve student engagement and understanding in various educational contexts. According to Akçayır and Akçayır (2017), the use of AR in education can increase learning motivation, conceptual understanding, and social interaction among students. In addition, a meta-analysis conducted by Garzón et al. (2019) revealed that AR-based media significantly enhances learning outcomes and student engagement when compared to conventional teaching methods.

However, most previous studies tend to focus on the impact of AR media or Joyful Learning separately, or are limited to general subjects such as science or language. There is still a lack of research specifically examining the integration of AR-based Flash Card media with Joyful Learning in the context of Informatics education, particularly on abstract topics such as computer systems. Moreover, few studies have explicitly measured the combined effect of these two variables on both collaboration and learning outcomes in middle school settings. This research aims to fill that gap by providing empirical evidence of how the synergy between innovative technology and engaging pedagogy can address the challenges of low collaboration and understanding in Informatics classrooms. This study employs a quasi-experimental method using a One-Shot Case Study design, in which measurements are taken only after the intervention using AR flash cards integrated with the Joyful Learning approach. The instruments used include learning outcome tests and observations of student collaboration. Thus, this research aims to develop AR-based flash card media

combined with the Joyful Learning approach and to examine its effectiveness in improving collaboration and Informatics learning outcomes among students.

2. Methods

This study utilized the Research and Development (R&D) method with the ADDIE development model, which includes five structured stages: Analysis, Design, Development, Implementation, and Evaluation. Chosen for its systematic and student-centered approach (Sugiyono, 2015; Rachma et al., 2023), ADDIE allows iterative evaluation at each phase to ensure effective learning media (Dick et al., 2005). During Analysis, learning issues and student needs were identified; in Design, AR-based flash card concepts were developed using a Joyful Learning approach; in Development, interactive AR media and evaluation tools were created; Implementation involved deploying the media in Informatics classes; and Evaluation included expert validation and effectiveness measurement. The study followed a quasi-experimental One Group Post-Test Only design, where students used mobile devices to interact with AR flash cards, enhancing collaboration and learning. Post-tests and observations were analyzed descriptively to assess media impact.



Figure 1. ADDIE Method Process Flow Chart

In Figure 1, each stage is interconnected, and the evaluation results at the final stage can be input for media revision and improvement (Safitri et al., 2024). This section combines the R&D development method with the systematic ADDIE model supported by the literature and includes simple tables and graphs to clarify the research process. If you need additional visual graphs or instrument details, I am here to help.

This study employed two primary instruments to gather data on student collaboration and learning outcomes. The first was the Student Collaboration Assessment Instrument, designed to evaluate collaborative skills during the use of AR-based flash cards in a Joyful Learning environment. Collaboration was assessed through structured observations and self-assessment questionnaires, with the observation instrument (Vygotsky & Cole, 1978; Slavin, 1995; Johnson & Johnson, 1999; Barron, 2003). It included six key indicators rated on a 5-point Likert scale: task sharing, communication, mutual support, respect for opinions, consensus building, and active participation. Observations were conducted by trained observers during group sessions. The first indicator, Sharing Tasks and Responsibilities, reflected students' ability to divide work and take responsibility, aligned with Slavin's (1995) Cooperative Learning theory and Johnson & Johnson's (1999) emphasis on structured roles. The second, Effective Communication, measures the expression of ideas and active listening (Webb, 1989; Barron, 2003). The third, Helping and Supporting Each Other, was rooted in Vygotsky & Cole's (1978) Zone of Proximal Development and Cohen's (1994) emphasis on peer assistance. Respecting Differences of Opinion, the fourth indicator, evaluates constructive engagement during disagreements (Dillenbourg, 1999; Jonassen, 2000). Fifth, Building Consensus, focuses on negotiation and compromise (Deutsch, 1949; Lai, 2011). Finally, Active Involvement assessed participation and engagement, referencing Prince (2004) work on Active Learning and the Joyful Learning

approach, which together emphasize student-centered, interactive group learning environments.

In addition to direct observation, students' perceptions of their collaborative experiences during group learning were assessed using a self-assessment questionnaire. This instrument was designed based on key indicators of collaboration and grounded in established theories and empirical studies on effective group learning. The questionnaire aimed to encourage student reflection on their level of involvement and interaction within their groups. The questions were organized into six main sections. The first section focused on sharing tasks and responsibilities, including whether members had clearly defined roles and participated in equitable task distribution (Slavin, 1995; Johnson & Johnson, 1999). The second section addressed effective communication, evaluating students' ability to express and receive ideas (Barron, 2003; Webb, 1989). The third covered mutual help and support, emphasizing peer assistance and encouragement (Vygotsky & Cole, 1978; Cohen, 1994). The fourth examined respect for differing opinions, encouraging respectful dialogue and open-mindedness (Dillenbourg, 1999; Jonassen, 2000). The fifth emphasized building consensus through shared understanding and compromise (Deutsch, 1949; Lai, 2011). Lastly, the active involvement section evaluated students' participation, engagement, and contributions to group success (Prince, 2004).

To assess students' cognitive learning outcomes after implementing Joyful Learning-based AR flash cards, a test was developed based on Bloom's Taxonomy (Anderson & Krathwohl, 2001), covering indicators like remembering (C1), understanding (C2), and applying (C3) through multiple-choice, short-answer, and case-based questions. Instrument validity and reliability were ensured through expert reviews in learning media, educational technology, and Informatics, and pilot-tested for internal consistency. Data collection involved post-tests for cognitive outcomes, direct observation for collaboration, and student questionnaires to capture perceptions. Observational and self-assessment instruments were validated to ensure the accuracy and consistency of data on collaboration and learning effectiveness.

3. Results

The process of developing Flash Card media based on Augmented Reality (AR) with the Joyful Learning approach follows the steps in the ADDIE model, namely Analysis, Design, Development, Implementation, and Evaluation. This stage begins with a needs analysis through observation and interviews with Informatics subject teachers of class VII at SMPN 18 Malang. It was found that students had difficulty understanding abstract concepts in the "Computer System" material, and were less involved in the collaborative learning process. Therefore, an interesting, interactive learning media is needed that is able to facilitate collaboration and conceptual understanding of students. The media design focuses on creating AR-marked flash cards that display 3D objects when scanned with a mobile device. The material is designed to cover hardware, software, and brainware components. In addition, learning activities are designed group-based with a Joyful Learning approach, which emphasizes games, exploration, and discussion to foster collaboration. At this stage, the researcher designed a prototype using the Figma application which has been presented in Figure 2.



Figure 2. AR Flash Card Design Plan

The media was developed using the Assemblr application to integrate virtual objects into flash cards. Media validation was carried out by media experts and material experts. The validation results showed a level of feasibility of "Very Good" with an average score of 91.2%. After validation, the media was tested on a limited basis to see the initial response of users. At this stage, the researcher developed the graphic visuals that had been created at the design stage and implemented them into Augmented Reality (AR) with 3D objects. This development has been presented in Figure 3.

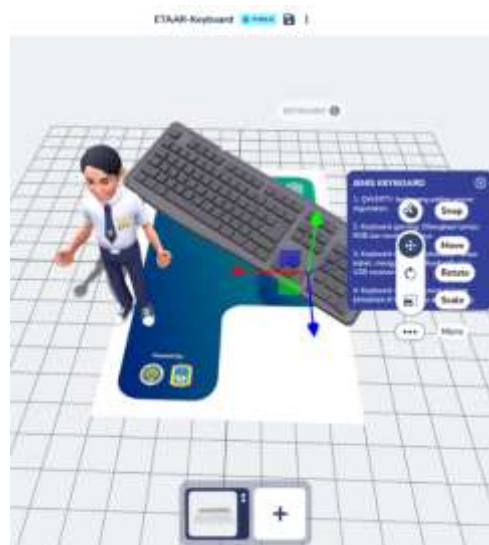


Figure 3. AR Flash Card Development

The media is implemented in the learning process in class VII with the One-Shot Case Study quasi-experimental method. Students are divided into groups and use AR flash cards in computer system concept understanding activities. The activity takes place in a fun and competitive atmosphere that encourages students' emotional and social involvement. At this stage, it is supported by the documentation presented in Figure 4.



Figure 4. Implementation Documentation

Evaluation of media effectiveness was conducted through a post-test that included 20 multiple-choice questions to measure learning outcomes, as well as student collaboration observation sheets that observed aspects of communication, cooperation, responsibility, and participation during learning.

This study employed a quasi-experimental One-Shot Case Study design to measure the effectiveness of Flash Card learning media based on Augmented Reality (AR) integrated with a Joyful Learning approach. The evaluation focused on two main variables: student collaboration and cognitive learning outcomes, which were measured through observation instruments and a written post-test, respectively. Student collaboration was observed using six key indicators: active participation, open communication, teamwork, group responsibility, decision making, and joint task completion.

Table 1. Percentage of Collaboration Indicators

Collaboration Indicators	Presentation of Activeness
Active Participation	91.1%
Open Communication	89.4%
Teamwork	87.3%
Group Responsibility	85.6%
Decision-making	83.3%
Joint Task Completion	88.7%

Based on Table 1, the average score across these six indicators was 87.6%, categorized as very good. These data indicate that the Joyful Learning approach, combined with interactive media, successfully created a learning environment that encourages students to actively interact, share ideas, and complete tasks collaboratively in a positive and enjoyable atmosphere.

Table 2. Percentage of Student Learning Outcomes

Value Range	Number of Students	Percentage
90 – 100	13 Students	33.3%
80 – 89	14 Students	43.3%
70 – 79	5 Students	16.7%
< 70	2 Students	6.7%

To assess students' cognitive understanding of the Computer Systems material, a post-test was administered to 34 students after the lesson. Based on Table 2, the class average score was 84.6 with a standard deviation of 7.2. A total of 93.3% of students (32 out of 34) achieved scores above the Minimum Mastery Criteria (KKM) set at 75. This indicates that the majority of students reached mastery and demonstrated a good understanding of the concepts in the computer systems material.

These data suggest that the use of AR-based Flash Card media combined with the Joyful Learning approach is highly effective in enhancing learning quality, both in terms of cognitive learning outcomes and social-collaborative interaction. The 3D visualization provided by AR helped students grasp abstract concepts more concretely, while the enjoyable learning atmosphere fostered deeper emotional and social engagement. Therefore, the results of this study support the hypothesis that Informatics learning using the Joyful Learning approach aided by AR media can serve as an innovative solution to address the challenges of low student understanding and collaboration, especially on technical and conceptual topics such as Computer Systems.

To provide a clearer picture of the effectiveness of using Augmented Reality (AR) based Flash Card media in improving student learning outcomes and collaboration, in Figures 5 the researcher presents two graphs that represent the level of collaboration between students and the distribution of post-test scores during the learning process.

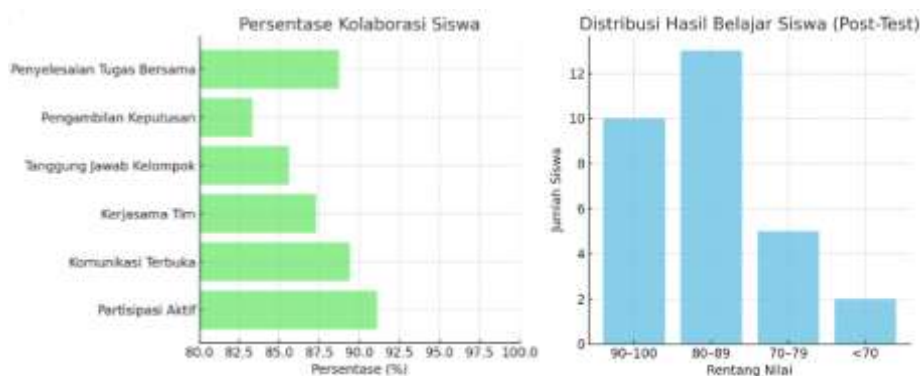


Figure 5. Percentage of Student Collaboration and Distribution of Student Learning Outcomes

4. Discussion

The results of this study showed that the use of AR-based Flash Card media was effective in enhancing both collaboration and learning outcomes of Grade VII students at SMPN 18 Malang in the topic of computer systems. Based on the post-test results, students achieved an average score of 85.3 out of 100, with a classical learning completeness percentage of 93.3% (28 out of 30 students scored above the minimum mastery criterion of 75). This indicates a significant level of cognitive mastery after learning with the AR media and Joyful Learning approach.

In terms of collaboration, observation, and self-assessment, data showed a high level of student engagement. The observation results recorded an average score of 4.36 out of 5 across six collaboration indicators, placing the collaboration performance in the "very good" category. The self-assessment questionnaire confirmed this, with an average student rating of 4.21, indicating a positive perception of their collaborative experience. These quantitative findings reinforce the qualitative observations of increased student participation, peer support, and active discussion during group tasks.

This finding is in line with Nasrulloh et al. (2022), who found that the use of AR media in learning increases cognitive engagement and motivation due to the presence of real and interactive learning experiences. Likewise, Widayanti (2020) emphasize that Joyful Learning can create a positive emotional atmosphere that encourages students to be more cooperative and active in class. When compared to conventional methods that tend to be teacher-centered, the combination of AR and

Joyful Learning not only improves outcomes but also increases emotional and social engagement among students.

The success of this approach is also supported by Vygotsky's Social Constructivism Theory, which posits that knowledge is constructed socially through meaningful interactions. The AR flash cards functioned as visual triggers that stimulated student curiosity and facilitated collaborative exploration of learning materials. These results are also in line with findings from Chang et al. (2014), who reported improvements in collaboration and concept mastery through AR-supported group learning. The integration of AR-based Flash Cards and Joyful Learning provides a powerful pedagogical innovation in Informatics learning. Not only does it improve cognitive achievement, but it also enhances essential 21st-century skills such as collaboration, communication, and critical thinking. These findings suggest that combining immersive technology and emotionally engaging pedagogy is a strategic and impactful approach in teaching abstract concepts like computer systems in secondary education.

5. Conclusion

Flash Card learning media based on Augmented Reality (AR) developed through the ADDIE model has proven to be feasible and effective for use in Informatics learning for class VII on Computer Systems material. This media is able to simplify abstract concepts through interactive 3D object visualization, and supports the Joyful Learning approach in creating a fun and collaborative learning atmosphere. The post-test results showed that 93.3% of students scored above the KKM with an average score of 84.6, and observations recorded that the level of student collaboration was in the "very good" category with a percentage of 87.6%. However, this study faced several obstacles, such as the limited AR supporting devices in schools and students' abilities in operating AR-based applications which were still diverse. In addition, the time available during class hours is often not enough to optimally explore the material through this medium. For further research, it is recommended to develop AR media that is lighter and compatible with various devices, as well as implementation in a more flexible learning duration. Research also needs to be expanded to different materials and levels to test the consistency of media effectiveness more broadly.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest.

Ethical Approval and Originality Statement

Ethical approval was obtained for this study. The manuscript represents original work and has not been previously published, nor is it under consideration by another journal.

Data Disclosure Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.



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