

Augmented Reality And Gamification: Learning Media To Improve Learning Motivation

Arie Eko Cahyono¹, Muhammad Nur Hudha², Mochammad
Maulana Trianggono³,
Muhammad Agus Sugiarto⁴

¹*Department of Economic Education, Faculty of Teacher Training and Education,
Universitas PGRI Argopuro Jember, Indonesia.*

²*Department of Science Education, Faculty of Teacher Training and Education, Universitas
Sebelas Maret, Indonesia.*

³*Department of Early Childhood Teacher Education, Faculty of Teacher Training and
Education, Universitas PGRI Argopuro Jember, Indonesia.*

⁴*Department of Early Childhood Teacher Education, Faculty of Teacher Training and
Education, Universitas PGRI Argopuro Jember, Indonesia.*

*Corresponding Author:
Arie Eko Cahyono*

*Department of Economic Education, Faculty of Teacher Training and Education,
Universitas PGRI Argopuro Jember, Indonesia Jawa Street, No. 10 Tegal Boto Lor, Sumber
Sari, Jember, Indonesia Email: arie.arion@gmail.com*

This study aims to explore the effects of using Augmented Reality (AR) technology and gamification in enhancing learning motivation and the understanding of money concepts among first and second-grade elementary school students. A total of 75 students from five elementary schools participated as respondents and were randomly divided into three groups: (1) students who only read the lesson materials, (2) students using an AR prototype, and (3) students using an AR prototype with gamification components. The study employed a web-based experimental method with a between-groups design to measure student motivation and their understanding of money concepts. The results indicate that the use of AR and gamification significantly improves student motivation and engagement compared to traditional learning methods. Students using the AR prototype with gamification demonstrated higher levels of motivation and a better understanding of money concepts. The study suggests that integrating AR technology and gamification can be an effective strategy in elementary education to enhance learning motivation and introduce complex concepts in an interactive and enjoyable manner.

Keywords: Augmented Reality (AR) Gamification Learning Motivation Elementary Education.

1. INTRODUCTION

The use of technology in primary education plays a crucial role in creating a learning environment that supports the cognitive, social, and emotional development of children [1]–[3]. Several studies have found that digital literacy not only equips children to face a future shaped by technology, but also plays a role in supporting their psychological and personality development [4]–[6]. Effective learning activities must be designed to adapt to the evolving needs of students, particularly in the increasing use of technology [7]. There are many benefits to introducing technology at an early age [8], [9]. For example, digital technology can be integrated with game-based learning, which can enhance children's engagement and creativity. The use of interactive multimedia in the learning process has been proven to significantly boost students' enthusiasm and initiative in learning [10]–[13]. The use of technology in learning should be designed to create collaborative learning environments to develop students' social skills [14], [15]. The integration of technology in primary education not only enriches the learning experience but also equips children with essential skills for the future [16]. The positive impact of technology on learning outcomes highlights the importance for educators to adopt these tools in their teaching practices.

Augmented Reality (AR) is an innovative technology that blends digital content with the real world, enhancing users' perception in real-time [4], [17]. The use of technology that combines digital content with the real world can enhance students' learning experiences and improve their learning outcomes [18]. The use of AR in the learning process can make education more interactive and encourage greater student engagement compared to traditional methods [4], [10]. The reasons for using AR in education are diverse. First, AR has been shown to enhance student motivation and engagement [10], [17], this is because AR can make learning more interactive and visually engaging, thereby capturing students' attention. Additionally, the use of AR applications positively impacts variables such as attitudes, motivation, and attention in the learning process [19]. Furthermore, AR can address specific learning needs, such as supporting children with dyslexia, by creating customized learning experiences that enhance concentration and cognitive development [20]–[22]. Integrating Augmented Reality into the learning process not only enriches the learning experience but also fosters student engagement and motivation. This is crucial in modern education, which emphasizes interactive student involvement in the learning process.

Augmented Reality (AR) has been tested several times with secondary school students, and the results indicate that AR can enhance learning motivation and improve learning outcomes [10], [23], [24]. Learning with AR can stimulate their interest and enthusiasm for studying [25]. The use of AR in education has been shown to increase student engagement and motivation [26]. For example, it has been found that AR applications positively influence students' motivation to learn by making lessons more interactive and enjoyable. AR encourages active participation in the classroom, which is crucial for learners who develop through interaction and hands-on experiences. Additionally, some studies suggest that AR can transform traditional learning environments into dynamic spaces that cater to various learning styles, thereby enhancing understanding and retention [23], [27]. Integrating Augmented Reality into the learning process not only boosts students' motivation but also enriches their learning experience, making education more engaging and effective. The integration of Augmented Reality (AR) in education has shown promising benefits for enhancing student motivation. Other research indicates that AR can significantly increase engagement and interest in learning activities. [28], [29].

Some studies suggest that although the use of Augmented Reality (AR) in learning can significantly boost student motivation, its effectiveness is optimized when combined with other elements such as gamification [28], [30]. These findings indicate that AR alone may not be sufficient to achieve maximum student engagement. Gamification, which involves incorporating game elements such as points, badges, and challenges, can provide an additional boost to students' intrinsic motivation. [28]. By combining AR and gamification, students can experience a more interactive, competitive, and enjoyable learning environment, which ultimately enhances active participation and the desire to continue learning [24], [31], [32]. The combination of these two technologies creates a dynamic learning environment that supports the achievement of better educational outcomes [33]. Combining AR with gamification and other teaching methodologies can impact motivation and learning outcomes. However, despite these advantages, there are still challenges in implementing AR in educational environments. It is crucial to integrate AR with learning strategies to maximize its impact on student motivation [34]. Gamification, defined as the application of game design elements in non-game contexts, has emerged as a powerful tool for enhancing intrinsic motivation in educational settings. [35]. By incorporating elements such as points, badges, and leaderboards, gamification transforms traditional learning experiences into engaging and interactive activities that can significantly boost student motivation. Research shows that gamification can enhance cognitive outcomes, motivation, and behavior, making learning more enjoyable and effective [30], [36], [37]. The role of gamification in enhancing intrinsic motivation is crucial, as it promotes a sense of autonomy, competence, and relatedness—key components of Self-Determination Theory. [16], [38]. For example, research has found that certain gamification elements can boost intrinsic motivation by addressing these psychological needs. Additionally, meta-analyses support the idea that gamification positively impacts motivation and learning outcomes across various educational contexts. [39]. However, there are still gaps in the current understanding of the effectiveness of gamification, particularly regarding its impact on enhancing students' intrinsic motivation for learning. Stronger empirical evidence is needed to substantiate the benefits of gamification in educational settings, especially concerning its effects on students' affective states and learning achievements. Additionally, while gamification shows promise, it is important to address technological challenges and integrate gamification with other pedagogical strategies to maximize its effectiveness. [31]. While gamification offers significant opportunities to enhance intrinsic motivation in education, further research is needed to explore its limitations and the potential benefits of combining it with other variables, such as Augmented Reality or collaborative learning strategies, to create a more holistic educational experience. [37], [40]. The combination of Augmented Reality (AR) and gamification in primary education has been recognized as a powerful strategy for enhancing student engagement and motivation. [41]. Integration leverages the strengths of both technologies to create an immersive and interactive learning experience that can significantly improve educational outcomes. [16], [33], [34], [42].

The combination of Augmented Reality (AR) and gamification in primary education, particularly for first and second graders, faces several challenges. Children at this age are still in a stage of cognitive development that requires more intensive guidance, so the use of technologies such as AR and gamification must be carefully designed to align with their capacities [1], [43]. Limitations in technology literacy and the potential distractions from game elements can reduce the effectiveness of learning, especially if there is insufficient support

from teachers or parents [44]. Additionally, the technology infrastructure in many primary schools in Indonesia is still limited, making widespread implementation of AR and gamification a significant challenge.

At the same time, introducing financial literacy, including the concept of money, is crucial for children in first and second grade [45], [46]. In Indonesia, early understanding of money helps children develop financial management skills that are critical for their future lives [47]–[49]. Early financial literacy not only teaches children to recognize money but also helps them understand basic concepts such as saving, distinguishing between needs and wants, and the value of spending [47], [50]. The application of AR and gamification in financial literacy education can make abstract material easier to understand and more enjoyable for children, helping them develop important financial skills from an early age.

2. METHOD

2.1 Research Design

This study aims to explore the effects of using Augmented Reality (AR) technology and gamification in enhancing learning motivation and the introduction of money concepts among first and second-grade elementary school students. The study employs a web-based experimental approach with a between-groups design to measure students' learning motivation and understanding of the provided material. A total of 75 students from five elementary schools were selected as respondents and randomly divided into three groups: (1) a group that only reads the lesson material, (2) a group that reads the lesson material followed by the use of an AR prototype, and (3) a group that reads the lesson material followed by the use of an AR prototype with gamification components.

2.2 Product Development

This application is designed to help primary school students in first and second grades understand basic money concepts through mobile devices such as Android. Using Unity, the application combines interactive games and augmented reality to create a fun and engaging learning experience. It incorporates gamification elements like tasks, points, leaderboards, and badges to motivate students. In each level, students will learn to recognize different types of money, understand their denominations, and practice using them through games designed with increasing difficulty. The application can also be used offline, except for certain data updates.

Model ADDIE (Analisis, Desain, Pengembangan, Implementasi, dan Evaluasi) diadopsi untuk studi ini [51]. Selama pengembangannya, sekelompok siswa berpartisipasi dalam memberikan masukan tentang desain dan fitur aplikasi. Mereka juga terlibat dalam pengujian aplikasi di berbagai tahap, memberikan umpan balik untuk meningkatkan kualitas pembelajaran. Data siswa disimpan dalam basis data SQL, memungkinkan mereka membandingkan kemajuan belajar dengan teman-temannya melalui papan peringkat. Dengan memanfaatkan analitik pembelajaran, aplikasi ini mengumpulkan informasi seperti waktu penyelesaian tugas dan jumlah kesalahan yang dibuat, yang digunakan untuk memberikan pengalaman belajar yang lebih personal dan efektif.

2.3 Experiment

The study involved 75 first and second-grade elementary school students from five different schools. The respondents were randomly divided into three groups. The first group consisted of students who only read the lesson material; the second group used the lesson material and the AR prototype; while the third group used the AR prototype equipped with a gamified quiz. The participants in this study were aged between 6 and 8 years. Data collection was conducted with respect to the confidentiality of students' personal information, and only anonymous data were used for research purposes.

2.4 Materials and Measurements

The learning materials used in this study included lesson notes and two AR prototypes. Each group was provided with materials according to their experimental condition, which included PDF-based lesson notes and a link to the AR prototype. The AR prototypes were developed as mobile-based web applications that allowed students to interact with 3D models through the provided QR code. In the third group, the AR prototype was equipped with gamification components consisting of 11 quiz questions, including multiple-choice, matching values with colors, and estimating values based on the given colors.

Students' learning motivation was measured using an online survey that adopted a modified version of the learning motivation assessment instrument. This survey was designed to measure students' learning motivation based on the ARCS model (Attention, Relevance, Confidence, Satisfaction) [29], [52], [53]. The results of this survey were used to analyze the impact of AR technology and gamification on students' learning motivation and their understanding of money concepts.

2.5 Procedure

Participants were identified and invited to participate in this study through school-based learning. After meeting the inclusion criteria, students were randomly assigned to one of three experimental groups. Each group received a notification containing information about the study's purpose, instructions on how to access the learning materials, and an estimated time needed to complete the survey. Upon completion of the experiment at each student's respective school, data were collected and analyzed using statistical software to obtain in-depth results.

3. RESULTS AND DISCUSSION

3.1 Research Results

3.1.1 Student Responses to the Application

The majority of students provided positive feedback regarding the use of the application in learning (85%) and believed that the application was easy for others to learn (90%). Additionally, they found it easy to use on their own (80%) because the various functions of the application could be utilized effectively (90%), which made them feel very confident while using it (80%). Conversely, students responded negatively when asked if the application was too difficult to use (80%) and if they felt there were any disruptions while using the application (90%). When asked if they needed technical assistance to use the application, most students answered no (75%), and when asked if they needed to learn something new before using the

application, they also answered no (80%). Finally, when asked if they found the application cumbersome to use, the majority of students gave a negative response (85%).

In terms of usage, most students were interested in the games provided (95%), were engaged with the games available (75%), and felt successful (60%), skilled (65%), satisfied (75%), challenged (60%), and happy playing the games (90%). Conversely, the majority of students responded negatively when asked if they had to exert a lot of effort (75%), felt tired (85%), bored (70%), frustrated (90%), and easily irritated (85%). These results highlight the positive impact of the application in minimizing negative effects and maintaining a low level of tension.

3.1.2 Learning Motivations

In this study, three modified versions of a learning motivation assessment instrument were used to test differences in motivation between three types of learning materials: (1) lecture notes, (2) an Augmented Reality prototype, and (3) an Augmented Reality prototype with gamification quizzes. The analysis results indicated significant differences in motivation between the group that only read lecture notes and the groups that used Augmented Reality or Augmented Reality with gamification.

The implementation phase involved testing Augmented Reality and Gamification-based learning media with first and second-grade primary school students. This trial provided valuable insights into the effectiveness of the media. Student motivation was measured before and after the implementation using pretest and posttest questionnaires. The results showed a 25% increase in motivation scores, indicating that the gamified learning environment significantly enhanced student motivation. Students reported enjoying the interactive challenges and felt more engaged in the learning process.

Table 1. Testing Results

No	Indicator	Only Read The Lesson Material		Used The Lesson Material and The AR Prototype		Used The AR Prototype Equipped With a Gamified Quiz	
		Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
1	Intrinsic Motivation	16 %	18 %	16 %	22 %	17 %	25 %
2	Competence and Achievement	17 %	21 %	17 %	22 %	18 %	24 %
3	Engagement and Participation	19 %	21 %	19 %	21 %	20 %	22 %
4	Autonomy and Independence	18 %	23 %	19 %	23 %	18 %	24 %
SUM		70 %	83 %	71 %	88 %	73 %	95

This study aims to evaluate the impact of using Augmented Reality (AR) and gamification elements on enhancing intrinsic motivation, competence, engagement, participation, and student autonomy. The experiment involved three groups receiving different treatments: the

first group only read the lesson materials, the second group used lesson materials with an AR prototype, and the third group used an AR prototype with gamification quizzes.

The results show that the third group, which used AR with gamification quizzes, significantly outperformed the second and first groups. In terms of intrinsic motivation, the third group was more motivated due to the challenge, rewards, and immediate feedback from the quizzes, which encouraged them to keep learning. Competence and achievement were also higher in this group, as the integration of gamification and AR allowed for deeper understanding through visual interaction and a more enjoyable learning experience.

Additionally, the engagement and participation levels in the third group were higher compared to the other groups. Students were more actively involved during the learning process because gamification encouraged them to participate more frequently and intensively. Finally, this group also demonstrated better autonomy and independence, as students felt they had more control over their learning process, were able to explore the material independently, and could complete the quizzes with minimal external help. Overall, the AR approach with gamification elements proved to be more effective in enhancing various aspects of learning compared to merely reading materials or using AR without gamification.

3.1.3 Gamification Analysis

In this study, gamification was applied through quizzes designed for first and second-grade primary school students with money recognition content. The quizzes consisted of 10 questions divided into three categories: (1) four multiple-choice questions testing students' ability to recognize different types of money (e.g., coins and banknotes), (2) three matching questions where students were asked to match images of items with the correct amount of money needed to buy them (e.g., matching an ice cream image with a price of Rp2,000), and (3) three simulation questions involving money for shopping, testing students' ability to calculate the total expenditure and provide change. For example, students were tasked with calculating the total expenditure for two simple items such as a pencil and an eraser, and determining the change from a given amount of money.

The results show that the accuracy level for the first category, multiple-choice questions, reached 75%, with most students able to recognize different types of money well, though some still had difficulty identifying larger denominations. In the second category, matching images, the accuracy was 100%, indicating that students could easily connect the concept of price with items. However, in the third category, involving simulation of money for shopping, the accuracy dropped to 66%. This indicates that when faced with more complex situations, such as calculating total expenditure and change, students still experienced difficulties.

The maximum quiz score was 100 points, with an average total accuracy of 75%. This result suggests that questions requiring critical thinking and simple calculations were more challenging for students, particularly in categories involving shopping simulations. One possible reason is that students may not have had sufficient time to practice using the AR prototype before the quiz began, leading some answers to be based on educated guesses rather than deep understanding. Additionally, students were not given the opportunity to revisit the material in the AR prototype to review concepts before the quiz, which may have resulted in a lack of comprehensive understanding of how money is used in daily life.

3.2 Discussion

This study reveals the impact of Augmented Reality (AR) technology and gamification elements on enhancing the learning motivation and understanding of first and second-grade primary school students regarding the concept of money. Based on the research findings, the AR-based learning approach with gamification quizzes is significantly more effective compared to the other two groups—those who only read the material or used AR without gamification. These findings underscore the importance of integrating technology and game elements in supporting learning at the primary education level.

Motivation, measured through intrinsic motivation, competence, engagement, participation, and student autonomy, showed a significant increase in the group using AR with gamification. This result supports the theory that gamification can enhance student engagement by providing elements of challenge, rewards, and instant feedback, all of which can boost interest and enjoyment in learning. In this group, students felt more motivated due to the gamification system offering incentives such as points and rewards, which fostered a sense of achievement and confidence. According to the ARCS model (Attention, Relevance, Confidence, Satisfaction), gamification plays a role in capturing attention (Attention) and making the material relevant (Relevance), while the challenge elements in the quizzes boost students' confidence (Confidence) and satisfaction (Satisfaction).

The use of AR with gamification also improved student competence and achievement. AR enables students to learn in a more interactive and visual way, significantly aiding first and second graders in understanding abstract concepts such as money denominations. Gamification adds a layer of challenge to the learning process, enhancing cognitive skills such as money recognition, calculating total expenses, and giving change. This indicates that interactive and game-based learning not only boosts motivation but also helps students build better competencies in understanding complex materials.

Student engagement in the AR with gamification group was significantly higher compared to the other groups. Students in this group actively participated in interactive quizzes designed to enhance their learning experience. This higher engagement level reflects that gamification not only makes learning more engaging but also strengthens students' connection with the material. This aligns with active engagement theory, which states that the more actively a student is involved in learning, the higher their chances of better understanding the material.

Students in the AR with gamification group also showed increased autonomy and independence in their learning. In this scenario, students were more able to explore the material independently, complete tasks, and quizzes with minimal teacher intervention. AR equipped with gamification allowed students to learn independently through engaging features that encouraged exploration. This independence is crucial for building students' abilities to manage their own learning processes and become more self-reliant in problem-solving.

Despite the generally positive results, there were challenges identified, particularly in the simulation questions involving money for shopping. In this category, accuracy dropped to 66%, with only a portion of students successfully answering correctly. This challenge may be due to limited time for students to practice using money through AR before the quiz, as well as difficulties in performing simple calculations. This suggests that while AR is effective in capturing attention and enhancing motivation, there is a need for more practice or guidance in topics that require critical thinking, such as financial transaction simulations.

4. CONCLUSION

The integration of Augmented Reality (AR) technology and gamification in primary education has a positive impact on student motivation and learning outcomes. AR can create an immersive and interactive learning experience, enhancing student engagement and helping them understand abstract concepts like money more easily. Gamification, through the use of game elements such as points and badges, further boosts intrinsic motivation by making learning more engaging and enjoyable. The study shows that using AR and gamification to teach the concept of money to first and second-grade students yields significant results in terms of learning motivation and material comprehension. The developed application, with this approach, is considered easy to use and engaging, with the majority of students giving positive feedback. Although there were some technical challenges, AR and gamification overall contribute significantly to creating an effective and enjoyable learning environment.

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