Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index

Vol. 11, No. 4 : December 2025
E-ISSN: 2442-7667
pp. 1479-1490
Email: jklppm@undikma.ac.id

Development of an Augmented Reality–Based Digital Simulation Game to Enhance Students' Empathic Character

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Abstract: This study aims to analyze students' levels of empathy and develop as well as evaluate the effectiveness of an Augmented Reality (AR)–integrated digital simulation game as a group guidance medium to enhance empathic character. The research employed a Research and Development (R&D) method using the ADDIE model, followed by an effectiveness test through a quasi-experimental design. A total of 208 students were initially screened, and 16 students with moderate empathy levels were selected and assigned equally to an experimental group and a control group. The empathy scale measured two key dimensions: cognitive empathy and emotional empathy. Data were analyzed using descriptive statistics and ANOVA to assess empathy scores, while expert and practitioner evaluations were examined using the Intraclass Correlation Coefficient (ICC) to determine the validity and consistency of the developed media. Descriptive findings showed an overall mean empathy score of 3.62 (SD = .55), with emotional empathy (M = 3.66) slightly higher than cognitive empathy (M = 3.58). The ANOVA test demonstrated a significant improvement in empathy after the intervention (F = 34.65; p = .000). These results indicate that the AR-based digital simulation game is effective in enhancing students' empathy. The use of AR-integrated digital media in counseling services is recommended as an innovative approach to foster emotional understanding, social awareness, and empathic behavior among students.

Article History
Received: 25-10-2025
Revised: 29-11-2025
Accepted: 08-12-2025
Published: 25-12-2025

Key Words:
Empathy; Group Guidance; Digital Simulation Games; Augmented Reality.

How to Cite: Naini, R., Rosada, U. D., Rohmadheny, P. S., Herdiansyah, D., Aditiono, W., & Aulia, S. S. (2025). Development of an Augmented Reality–Based Digital Simulation Game to Enhance Students' Empathic Character. *Jurnal Kependidikan : Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran, Dan Pembelajaran*, *11*(4), 1479-1490. https://doi.org/10.33394/jk.v11i4.18552

https://doi.org/10.33394/jk.v11i4.18552

Introduction

Adolescence is a phase of development characterized by complex social and emotional changes, during which individuals begin to build their identity and expand their social relationships beyond the family. One psychological aspect that plays an important role in this phase is empathy, which is the ability to understand and feel the emotions of others (Kral et al., 2017; Miklikowska et al., 2022). Empathy is closely related to psychological well-being, social adjustment, and prosocial behavior (Castillo et al., 2013; Mestre et al., 2019), and functions not only as a social skill but also as the moral and emotional foundation that guides adolescents' interactions within their social environment (Wang et al., 2024; Zhao et al., 2023). Therefore, strengthening empathy is essential for supporting the development of an adaptive and socially responsible young generation.

A large body of research has identified multiple factors that influence empathy development during adolescence. Social factors—particularly peer relationships—play a critical role. Miklikowska et al. (2022) ound that friendships with highly empathic peers can

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E-ISSN: 2442-7667
pp. 1479-1490
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enhance other adolescents' empathic abilities through social learning and emotional support. Similarly, adolescents with emotionally sensitive and caring peers tend to exhibit higher empathy and prosocial behavior (Gleason et al., 2009), whereas relationships with low-empathy peers may hinder emotional understanding (Miklikowska et al., 2022). Parenting factors also contribute significantly; Boele et al. (2019) emphasize that warm and responsive parenting fosters adolescents' empathic abilities through emotional learning in the family environment.

Environmental experiences and emotional conditions further shape empathy. Exposure to high-risk or stressful environments may reduce empathy and disrupt emotional recognition (Quas et al., 2017), with emotional regulation acting as a mediating factor. Excessive empathy without adequate emotional regulation can also lead to emotional distress. Van Lissa et al. (2017) report that adolescents with high empathy may experience emotional dysregulation—especially during interpersonal conflicts with parents—which negatively affects psychological well-being. These findings highlight that empathy has both adaptive and potentially maladaptive dimensions, underscoring the need for interventions that combine empathy-building with healthy emotional regulation.

Educational interventions have emerged as a promising avenue for fostering empathy. Programs based on emotional intelligence and mindfulness have been shown to reduce aggression and enhance adolescents' ability to understand and respond to others' feelings (Castillo et al., 2013; Silveira et al., 2023). Compassion meditation and school-based social-emotional learning (SEL) contribute to empathy and prosocial behavior (Mascaro et al., 2013; Salem et al., 2023). Development of moral reasoning also interacts reciprocally with empathy, strengthening prosocial tendencies and social solidarity (Mestre et al., 2019). Additionally, Miklikowska's (2018) notes that empathy can reduce social prejudice and promote inclusivity in multicultural contexts. Although these programs demonstrate meaningful effects, many rely on traditional, non-immersive pedagogical activities that may not fully engage adolescents or provide realistic emotional experiences—indicating a limitation in current empathy-focused interventions.

Immersive tools like augmented reality (AR) are increasingly recognized in education for their ability to deliver realistic social and emotional experiences in controlled learning settings, thereby supporting the development of empathy. Its immersive and interactive features enable repeated exposure to moral and social dilemmas, facilitating deeper internalization of empathic responses (Das et al., 2017; Varina et al., 2022). Such experiences strengthen both cognitive and affective empathy by allowing adolescents to anticipate the emotional consequences of their actions (Mateus Francisco et al., 2024; Miklikowska et al., 2022). Neuroscience research supports the role of AR in stimulating brain networks involved in perspective-taking and affective resonance, which undergo rapid maturation during adolescence (Kral et al., 2017; Zhao et al., 2020).

AR-based simulations also serve as a bridge between emotional learning and real-world application when combined with structured pedagogical components. Kokmandzhiev and Dagbaeva (2025) demonstrate that AR interventions integrated with reflection and guided discussion significantly improve empathic understanding. Post-simulation reflection strengthens long-term empathy retention by encouraging adolescents to analyze emotions, evaluate decisions, and articulate insights (Marques et al., 2022).

Practical applications of AR in guidance and counseling settings show transformative potential. Amashi & Baligar (2024) report that role-based digital scenarios can train students to manage issues such as bullying, discrimination, and peer conflict. Similarly, Ferreira et al. (2025) show that AR and VR can enhance emotional awareness and social support skills—

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key competencies for students and counselors. Such technology contributes to the development of an empathetic and inclusive school climate, helping adolescents navigate social diversity (Prediger et al., 2021). Furthermore, AR has shown positive impacts on engagement, motivation, and affective learning (Shihab et al. 2023; Rodda et al.2025), reinforcing its value in empathy-building. Integrating storytelling, reflection, and collaboration within AR environments can transform empathy into a meaningful and personally relevant experience(Hollaender et al., 2023; Kuanbayeva et al., 2024).

Although findings are promising, major gaps remain in AR-based empathy research, including limited use of structured pedagogical formats, lack of realistic adolescent-focused simulations, and minimal exploration of guided reflection or school counseling contexts. To address these gaps, this study develops an AR-integrated digital simulation game and tests its effectiveness in group guidance settings to enhance students' empathy, providing an innovative medium for supporting socio-emotional development.

Research Method

This study employed a Research and Development (R&D) design using the ADDIE model, which consists of five systematic stages: Analysis, Design, Development, Implementation, and Evaluation (Branch & Varank, 2009). The ADDIE framework was utilized to guide the development of digital game-based group guidance services aimed at enhancing students' empathy. The Analysis stage identified students' needs and existing issues related to empathy; the Design and Development stages produced the digital game–integrated counseling model; the Implementation stage carried out tryouts in real counseling settings; and the Evaluation stage assessed the model's effectiveness. To assess its impact, a quasi-experimental pretest–posttest control group design was used to measure changes in students' empathy following the intervention.

In the analysis stage, data were collected from 208 junior high school students. During the development and expert evaluation stages, the product was assessed by three material and media experts and three guidance and counseling teachers. In the implementation and final evaluation stages, students' empathy levels were categorized using cut-off scores derived from the normative distribution of the empathy scale. Because the intervention was designed as a preventive developmental program, students in the *moderate and low* empathy categories were included as the target group. From this pool, 16 students who met these criteria were selected and then divided evenly into the experimental and control groups to ensure comparable group composition.

The main variable in this study is Empathy, defined as the ability to understand and feel the emotional condition of others and to respond appropriately. The instrument used is a 4-point Likert-based *Student Empathy Scale* (1 = strongly disagree to 4 = strongly agree). The scale consists of two dimensions: 1) Cognitive Empathy, referring to the ability to understand others' perspectives, 2) Emotional Empathy, referring to the ability to feel others' emotional experiences. The instrument demonstrated high reliability, with a Cronbach's Alpha value of 0.87, indicating strong internal consistency. In the development stage, evaluation sheets were also used for expert and practitioner assessment. These consisted of:

a) Expert Validation Sheets for three material/media experts, covering aspects such as content accuracy, alignment with objectives, clarity of instructions, and media quality.
b) Guidance and Counseling Teacher Assessment Sheets for three practitioners, focusing on practicality, usability, clarity of procedures, and feasibility for implementation in school counseling settings.

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These instruments were used to determine the feasibility and quality of the developed digital game-based group guidance model before implementation with students. The expert and practitioner evaluations, assessed through ICC values across indicators of satisfaction, usefulness, ease of learning, and ease of use for both the guide and media. The research procedure followed the ADDIE model:

a) Analysis: identifying students' empathy levels through data from 208 students, reviewing needs, and preparing instruments and research permits.
b) Design: designing the structure, content, and flow of the digital game-based group guidance model.
c) Development: developing the product and validating it through expert assessment (three material and media experts) and practitioner evaluation (three guidance and counseling teachers). Revisions were made based on their feedback.
d) Implementation – applying the developed model to 16 students, where the experimental group received four sessions of digital game-based group guidance (45 minutes per session), while the control group continued regular activities without the intervention.
e) Evaluation – conducting pretest and posttest using the empathy scale to measure improvements in cognitive and emotional empathy after the intervention.

Data analysis consisted of descriptive and inferential statistical procedures. Descriptive analysis was used to present the mean, standard deviation, and distribution of students' empathy levels. Prior to the experimental phase, expert and practitioner assessments of the developed model and media were analyzed using the Intraclass Correlation Coefficient (ICC) to determine the consistency and agreement among the three material and media experts and three counseling practitioners. The ICC results indicated strong inter-rater reliability, supporting the feasibility of the developed product. Inferential analysis using one-way ANOVA was conducted to examine differences between the experimental and control groups. Before hypothesis testing, prerequisite analyses were performed, including the normality test (Shapiro–Wilk) and homogeneity test (Levene's Test), both showing that the data were normally distributed and homogeneous ($p > 0.05$).

Results and Discussion

Student Empathy Description

Descriptive analysis results show that the overall average student empathy score is 3.62 (SD = .55) on a 4-point Likert scale. This value indicates that the level of student empathy is generally in the moderate to high category. When viewed by dimension, the average score for emotional empathy is higher (M = 3.66; SD = .53) than cognitive empathy (M = 3.58; SD = .60). This indicates that students tend to be more emotionally responsive to the feelings of others than they are able to understand the perspectives of others cognitively. Thus, the affective dimension of empathy appears to be more prominent than the cognitive aspect.

Distribution of Student Empathy Levels

The distribution of empathy levels shows that most students are in the moderate category (53.8%), followed by the high category (37.5%), while only 8.7% of students are in the low category. These findings indicate that the majority of students already have a fairly good level of empathy, but character education programs still need to be strengthened to help develop empathy in students in the moderate and low categories.

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Table 1. Students' Emphaty Levels

Level	Frequency	Percentage
High	78	37,5%
Medium	112	53,8%
Low	18	8.7%

Judgement Analysis

The Intraclass Correlation Coefficient (ICC) was calculated using the ICC(2,6) model, which is a two way random effects model with average measures. This model was selected because the six raters consisting of three material and media experts and three guidance and counseling teachers were considered representative of a broader population of professionals, and the aim was to assess the reliability of their mean ratings.

Table 2. Interclass Correlation Coefficient Analysis

Product	Evaluated Aspect	Experts ICC	Description	GC Teachers ICC	Description
Guidebook	Satisfaction	.750	Moderate	.600	Moderate
	Usefulness	.750	Moderate	.750	Moderate
	Easy for Learning	.857	Moderate	.750	Moderate
	Easy for Use	.750	Moderate	.750	Moderate
Media	Satisfaction	.750	Moderate	.538	Moderate
	Usefulness	.750	Moderate	.750	Moderate
	Easy for Learning	.857	Good	.889	Good
	Easy for Use	.750	Moderate	.750	Moderate

Notes: Experts : 3 Raters; Guidance and counseling Teachers : 3 Raters. Referense: Koo & Li (2016) indicator estimate ICC : Excellent (ICC > .90); Good (.76 - .90); Moderate (.5 - .75); Poor (ICC < .50).

Overall, the ICC values show moderate to good agreement among both experts and practitioners, indicating that the product is consistently rated as feasible, useful, and easy to learn and use according to Koo & Li's (2016) criteria.

Experimental Results

Descriptive analysis of the experimental group showed an increase in empathy scores from 68.7 (SD = 9.1) on the pretest to 76.5 (SD = 8.3) on the posttest. This increase indicates a positive change in students' empathy levels after they participated in digital game-based group guidance services.

Table 3. Experimental Analysis Results

Variable	Pretest (M)	Pretest (SD)	Posttest (M)	Posttest (SD)
Empathy	68.7	9.1	76.5	8.3

Before conducting the hypothesis test, assumption checks for normality and homogeneity were carried out. The Shapiro–Wilk test indicated that the empathy scores were normally distributed ($W = .957$, $p = .382$). The Levene test confirmed that the variance between groups was homogeneous ($F = 1.087$, $p = .316$). Thus, the data met the prerequisites for ANOVA analysis. The ANOVA results showed a significant effect of the digital game–based group guidance intervention on students' empathy ($F = 34.65$, $p < .001$), indicating that the intervention effectively enhanced both cognitive and emotional empathy. Overall, the findings demonstrate that student empathy can be enhanced through simulation-based digital games that offer interactive and reflective learning experiences. The rise in empathy scores following the intervention suggests that engaging students in virtual social scenarios helps strengthen their capacity to recognize and relate to others' emotions. This indicates that digitally developed educational media can serve as an innovative approach for fostering empathy within school settings. This study shows that integrating Augmented Reality (AR) into digital simulation games significantly enhances students' empathy. Both cognitive

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empathy—especially perspective-taking—and affective empathy increased, with affective gains slightly higher.

Engaging with realistic socio-emotional scenarios in AR strengthens affective empathy—especially empathic concern—consistent with Davis's framework. These improvements also reflect Vygotsky's view that socio-emotional understanding develops through meaningful mediated interaction and Kolb's idea that reflection on concrete experiences enhances emotional and cognitive processing. Psychologically, AR's high interactivity triggers emotional engagement by activating both cognitive and affective components of empathy. Through immersive, concrete experiences and guided reflection, AR enables learners to construct personal meaning from virtual social situations, leading to deeper internalization of empathic values rather than mere conceptual understanding (Kolb, 2014 and Kolb et al.,2014).

Furthermore, from a social constructivist perspective (Vygotsky, 1978 in Azzahra et al., 2025), the collaborative and interactive AR environment promotes empathy through social mediation. By engaging in role-playing, moral dilemmas, and feedback-rich scenarios, students construct meaning through dialogue and shared reflection. Role-playing helps them experience others' perspectives, moral dilemmas prompt value-based decision-making, and feedback clarifies the consequences of their actions. Together, these elements form a holistic empathy-building cycle that integrates feeling, thinking, and acting, explaining the effectiveness of AR simulation games in enhancing students' empathy.

The results of this study align with previous findings showing that AR-based digital simulations effectively enhance empathy and other socio-emotional skills. For instance, AR history cards have been found to improve historical empathy by strengthening mental schemas and providing more concrete event visualization (Çakiroğlu et al., 2023). Similarly, Efstathiou et al. (2018) showed that AR field trips significantly boosted students' historical empathy and conceptual understanding compared to traditional methods. Together, these studies support the idea that immersive AR experiences can facilitate perspective-taking and emotional understanding—key components of empathy.

Beyond the context of history education, a number of recent studies confirm the effectiveness of AR and VR in developing empathy across social and professional domains. Nakazawa et al. (2023) showed that AR-based affective training improved caregivers' physical skills and empathy toward dementia patients, while Hollaender et al. (2023) hrough the AREduX prototype, found that AR-based dementia symptom simulations encouraged higher empathetic responses and had a positive impact on patient care quality. Similar findings were reported by Tay et al. (2023), who found that AR/VR interventions can increase knowledge, attitudes, and empathy toward individuals with mental disorders, as well as reduce social stigma. In the context of communication and social engagement, Girginova et al. (2024) emphasized that AR-based campaigns developed collaboratively by the community can foster self-identification and empathy between the audience and the content. Even in the context of disaster media, Huang (2024) found that AR-based disaster news increases prosocial behavioral intentions through increased physical presence and empathy, not merely a response to technological features.

The findings of this study are also consistent with the results of López-Faican et al. (2023), in which the EmpathyAR game, which combines AR and geolocation, effectively increased empathy and prosocial behavior in children and adolescents, including in a multiplayer gaming environment in secondary schools. Lacle-Melendez et al. (2024) research using the IRI likewise confirms that AR and VR effectively enhance empathy, though larger and longer-term studies are still needed. This consistency supports the conclusion that AR's

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immersive experiences boost both emotional resonance and the cognitive processes involved in understanding others' feelings.

In the field of game-based learning (GBL), various studies also support these findings by showing that digital games can improve emotional understanding, perspective-taking, and prosocial behavior. For example, Mohan et al. (2025) ound a significant increase in empathy scores among nursing professionals in India through game-based interventions, while Hudnall & Kopecky (2020) reported improvements in communication skills and emotional responses among healthcare workers through the Empathy Project game. A similar approach was applied in Lu et al. (2018) with an empathy board game that effectively developed empathy in nursing students through interaction, competition, and storytelling. In the context of early childhood education, Wu et al. (2020) proved that hybrid learning designs that combine real social interaction and digital representation can naturally improve children's empathetic perceptions and social skills.

Similar results were also found in the context of role-playing and digital simulations. Komisaryk et al. (2024) showed that role-playing games effectively develop empathy in prospective inclusive early childhood teachers, while Koivisto et al. (2025) confirmed that VR simulations in nursing education increase empathy and positive user experiences. Other studies, such as Mukund et al. (2022) and Kral et al. (2017), affirm that empathy-based digital games can improve social-emotional competencies and even alter neural activity related to emotion processing. In general, these various studies show that the success of GBL in fostering empathy is highly dependent on the narrative design, immersion level, and social interaction presented in the game (Papoutsi et al., 2021; Ratka, 2018). The findings confirm that combining AR interactivity with game-based learning creates an effective environment for building empathy across cognitive (perspective-taking), affective (emotional resonance), and behavioral (prosocial) dimensions, positioning immersive technology as an affective-cognitive bridge in digital-age character education.

Theoretically, the study shows that AR-based simulations can accelerate empathy development by integrating these components within immersive experiences. Empathy is shaped not only through social reflection, as Vygotsky suggests, but also through embodied simulation in virtual environments, making AR a "virtual empathy lab" for repeated and measurable empathic experiences. The study also proposes a model connecting presence, emotional immersion, and behavioral empathy, showing that higher presence and immersion lead to stronger internalization of empathic behavior. Overall, the results expand traditional empathy theory into immersive digital learning and introduce a new framework for affective learning in AR-based education.

Because the empirical results show a significant increase in student empathy, the findings directly guide curriculum design, teacher training, and AR integration. For curriculum design, the demonstrated effectiveness of AR in enhancing perspective-taking supports the use of AR-based scenarios that expose students to moral dilemmas and diverse social contexts (AlGerafi et al., 2023). For teacher training, the increase in emotional and cognitive empathy highlights the need to equip teachers with skills in empathic-technology pedagogy so they can effectively facilitate AR-supported reflective learning (Aldeeb et al., 2024; Koumpouros, 2024). For AR integration, the mechanisms that produced the empathy gains in this study emphasize the importance of first-person perspectives, narrative-driven tasks, and interactive ethical feedback to sustain students' emotional engagement and moral reasoning.

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Conclusion

The results of the study show that students' empathy levels are generally in the moderate to high category, with emotional empathy slightly more dominant than cognitive empathy. After being provided with digital game-based group guidance services, there was a significant increase in students' empathy scores. These findings confirm that a digital game-based approach can be an effective strategy in developing students' empathic abilities, both in terms of understanding and emotional responses to others. The findings of this study have important implications for guidance and counseling practices in schools. First, a digital game-based approach can be used as an innovation in group guidance services that is interesting and relevant to the world of students, especially in fostering empathy and social sensitivity. Second, school counselors can integrate interactive digital media into character development programs, so that students not only understand the concept of empathy cognitively but also experience it emotionally through simulations and interactions in games. In addition, the results of this study can be used as a basis for the development of technology-based guidance modules that focus on increasing empathy and other social skills.

Recommendation

Teachers are encouraged to incorporate AR-based simulation activities into character education and guidance services, as the intervention effectively improved students' cognitive and emotional empathy. They should also lead structured reflection sessions and use observational assessments to complement self-reports. For curriculum and media developers, the findings highlight the importance of creating AR modules with richer scenarios and longer implementation periods to maximize immersive, first-person learning. Future researchers should use larger and more diverse samples, apply mixed-method designs, extend intervention durations, and examine factors such as game type, narrative complexity, and learner characteristics. Longitudinal studies are also needed to assess the long-term sustainability of empathy gains.

Acknowledgment

This research was financially supported by Universitas Ahmad Dahlan (UAD) through its institutional research funding scheme. The author would like to express sincere appreciation to the principal, school counselor, and students of SMP Negeri 12 Yogyakarta for their active participation and cooperation during the study. Gratitude is also extended to colleagues and reviewers whose valuable insights contributed to the improvement of this research and its publication.

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E-ISSN: 2442-7667
pp. 1479-1490
Email: jklppm@undikma.ac.id

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