

Research Article

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Enhancing Conflict Resolution Skills through Artificial Intelligence-Based Problem-Based Learning in Civic Education at Indonesian Primary Schools

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Abstract

Background/Purpose. This study investigates the effectiveness of integrating Artificial Intelligence (AI) with Problem-Based Learning (PBL) to enhance high school students' conflict resolution skills within the context of civic education. The initiative responds to the increasing need for pedagogical models that simultaneously foster ethical reasoning, empathy, and peaceful negotiation in adolescent learners, particularly in complex socio-political environments.

Materials/Methods. Using a quasi-experimental one-group pretest-posttest design, the study was conducted with 90 eleventh-grade students from three urban schools in Yogyakarta, Indonesia. The intervention utilized a custom-built AI platform featuring real-time simulations of social conflicts, an NLP-based chatbot for ethical guidance, and personalized feedback mechanisms. Conflict resolution skills were measured across three core dimensions: empathy, peaceful negotiation, and ethical reasoning.

Results. Statistical analyses showed significant improvements across all assessed indicators ($p < 0.001$), with very large effect sizes (Cohen's $d > 1.6$). Post-test scores not only increased in average value but also displayed more uniform distribution, indicating effectiveness across diverse student profiles. No significant gender-based differences in learning gains were observed, suggesting the model's inclusivity. Regression analysis revealed that students with lower baseline scores experienced the greatest improvements, underscoring the adaptive strength of the AI-PBL approach.

Conclusion. The findings support the potential of AI-enhanced PBL to develop both cognitive and affective aspects of conflict resolution skills in civic education. Theoretically, this research contributes to social constructivist and differentiated instruction paradigms. Practically, it offers a promising direction for equitable technology integration in education. However, the absence of a control group and the urban-limited sample constrain broader generalization. Future studies should explore longitudinal and cross-cultural applications to evaluate the model's sustainability and scalability.



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1. Introduction

In an increasingly interconnected and diverse global society, conflict resolution skills have emerged as fundamental competencies that transcend traditional academic boundaries to include character building, democratic citizenship, and social cohesion. The capacity to constructively navigate interpersonal disagreements, demonstrate empathy across cultural differences, and engage in peaceful negotiations represents important life skills that education systems around the world must systematically develop. Therefore, conflict resolution skills are key skills of the 21st century that are an integral part of the formation of students' character and civic identity (Hadjichambis & Paraskeva-Hadjichambi, 2020; Johnson & Johnson, 2016; Wahyu & Pamungkas, 2025; Xu et al., 2019). In this context, conflicts between individuals, between groups, and between citizens and institutions are often not resolved constructively, thus having a long-term impact on social cohesion (Fonseca et al., 2019; Juvonen et al., 2019). Civic education that normatively contains the values of democracy, tolerance, and deliberation must play a strategic role in equipping students with the competence to resolve conflicts peacefully. However, the implementation of Civic Education in schools often still focuses on cognitive and normative aspects, without involving affective and contextual dimensions in depth (Tarozi & Torres, 2016a; UNESCO, 2017). As social tensions continue to emerge in daily life, the urgency to equip students with concrete conflict resolution skills is becoming increasingly undeniable (Jordan & Troth, 2021; Rachmad, 2022).

In the Indonesian context, additional cultural factors exacerbate these challenges. The nation's cultural emphasis on harmony and indirect communication patterns creates complex dynamics in which students can avoid direct confrontation while having no constructive alternatives to address disagreements. In addition, rapid social change and increasing ideological polarization create an urgent need for educational interventions that maintain cultural sensitivity while developing practical conflict resolution tools. At the same time, the development of digital technology and artificial intelligence (AI) opens up new opportunities to design more interactive, personalized, and real-world problem-based learning. Problem-Based Learning (PBL) approaches that have been proven to improve critical thinking and cooperation skills are relevant to be applied in the context of value education (Baser et al., 2017; Basilotta Gómez-Pablos et al., 2017; Rahmawati et al., 2020). When PBL is combined with AI-based systems, learning interactions can be modified to be more reflective and adaptive according to the needs of students (Bharathi et al., 2024; Demartini et al., 2024). AI has the potential to act as a reflective agent and facilitator capable of providing real-time feedback, helping students evaluate decisions, as well as stimulating ethical reasoning in digitally simulated conflict situations (Luckin & Holmes, 2016). These technological capabilities are closely aligned with constructivist learning theories that emphasize the construction of active knowledge through authentic problem-solving experiences. To this end, the combination of PBL and AI not only modernizes learning strategies but also expands the scope of pedagogical approaches that can respond to the complexity of social and ethical dynamics in the real world (Fontejn & Dolmans, 2019; Hung et al., 2019; Saqr & López-Pernas, 2023).

Despite the theoretical promise of the AI-enhanced approach to PBL, significant empirical gaps remain in understanding its effectiveness for developing social and ethical competence, especially in the context of civic education. A systematic examination of the existing literature reveals three critical research gaps addressed by this study: 1) insufficient empirical evidence on the effectiveness of AI-PBL for social skills development. Most of the existing research on AI in education focuses primarily on cognitive outcomes, academic achievement, and the acquisition of technical skills (Azucar et al., 2018; Barricelli et al., 2019). The dimensions of affective and social learning—particularly complex competencies such as empathy, negotiation skills, and ethical reasoning—remain significantly under-explored in the context of AI-enhanced education. 2) the absence of a validated framework for evaluating AI-integrated citizenship education interventions. While civics education research

recognizes the importance of experiential learning and character development, empirical studies examining how AI technology can systematically support these goals are scarce (Jamalova, 2024; Sá et al., 2021). 3) limited understanding of the effects of differential learning in an AI-PBL environment. The existing literature provides insufficient insight into how AI-enhanced PBL approaches affect diverse student populations, particularly regarding gender differences, basic skills variations, and cultural contexts in developing countries (Cranton, 2023; Luckett & Shay, 2020).

In this case, most of the existing research still focuses on content mastery and academic achievement. Not much research has been conducted on how these digital interventions can shape students' interpersonal skills and character in a systematic and measurable manner (Azucar et al., 2018; Barricelli et al., 2019). This is an important research gap that needs to be bridged, especially to align character education with the needs of a complex and challenging digital society (Jamalova, 2024; Sá et al., 2021). In fact, in the midst of social disruption due to technology and ideological polarization, conflict resolution has become an integral part of life skills that must be integrated into the national curriculum in a transformative manner (Cranton, 2023; Luckett & Shay, 2020). For this reason, this study aims to test the effectiveness of AI and PBL-based learning models in improving students' conflict resolution skills in Civic Education lessons. The significance of this research extends across multiple domains. Theoretically, this contributes to the emerging literature on technology-enhanced civic education. Practically, it offers guidance for education practitioners and policymakers who want to implement technology-based solutions for character education. Focusing on the Indonesian context, this study discusses the critical need for educational research that examines the integration of technology in diverse cultural environments.

In turn, the study also explored the contribution of each aspect of skills (empathy, negotiation, ethical reasoning), examined the equality of effects by gender, and analyzed the extent to which initial scores influenced the final outcome. With a quasi-experimental approach and strong quantitative data support (Baker C, 2018; Roof, 2015; Rogers & Revesz, 2019), this research is expected to make a theoretical and practical contribution to the development of character education models that are adaptive to the challenges of the 21st century. This research exists as an effort not only to answer the current pedagogical needs, but also to design a relevant, inclusive, and sustainable technology-based value education foundation. Based on this description, the formulation of the problem in this study is as follows:

1. Are the Artificial Intelligence and Problem-Based Learning models effective in improving students' conflict resolution skills in Civics Education subjects?
2. How did each indicator—empathy, peaceful negotiation, and ethical reasoning—contribute to changing students' skills after the intervention?
3. Is there a difference in improving conflict resolution skills based on students' gender?
4. To what extent can students' initial scores predict the level of improvement in skills after participating in the intervention?

2. Literature Review

Conflict resolution is widely recognized as a critical 21st-century skill, particularly in the context of civic education, where students are expected to navigate complex social dynamics and contribute to democratic societies (Byrd et al., 2016; Hadjichambis & Paraskeva-Hadjichambi, 2020). However, traditional civic education in many countries, including Indonesia, often emphasizes cognitive and normative aspects over experiential and affective dimensions, limiting students' opportunities to practice real-life conflict mediation (Henriques & Brilha, 2017; Tarozi & Torres, 2016).

Problem-Based Learning (PBL) has emerged as an effective pedagogical model that fosters critical thinking, collaboration, and problem-solving through real-world scenarios. Its constructivist foundation aligns with the goals of civic education by encouraging learners to actively engage with ethical dilemmas and social issues (Henriques & Brilha, 2017; Tarozzi & Torres, 2016). Research has shown that PBL can improve students' interpersonal skills and deepen moral reasoning, especially when learners are placed at the center of inquiry-driven processes (Baser et al., 2017; Muñoz-Repiso & Gómez-Pablos, 2017).

In recent years, Artificial Intelligence (AI) has been increasingly integrated into educational settings, offering adaptive feedback, personalized learning paths, and immersive simulations that respond to individual learner needs (Demartini et al., 2024; Luckin & Holmes, 2016). AI-powered tools such as chatbots and decision-based learning environments can support students in navigating ethical challenges and emotional reasoning during simulated conflicts (Bharathi et al., 2024; Saqr & López-Pernas, 2023). These technologies not only enhance cognitive engagement but also provide safe, judgment-free spaces for students to explore diverse conflict resolution strategies.

Despite these advancements, few empirical studies have examined the synergy between AI and PBL in the specific context of civic education, particularly in developing countries. Most existing literature focuses on academic achievement or technical skill development, with limited attention to how AI-based learning affects students' social and affective competencies (Azucar et al., 2018; Barricelli et al., 2019). This gap presents an urgent need for research that explores how digital pedagogies can cultivate values-based education and equip students with the interpersonal and ethical tools necessary for navigating a rapidly changing society.

3. Methodology

A. Research Design

This study uses a quantitative approach with a quasi-experimental design of a one-group pretest-posttest design (Kurki et al., 2021; Ventura et al., 2021). This design was chosen because it allowed researchers to measure changes in conflict resolution skills before and after the application of Artificial Intelligence and Problem-Based Learning (AI-PBL)-based learning models. Although it did not involve a control group, the design remained relevant in the context of experimental education aimed at measuring the effectiveness of interventions directly in authentic situations.

This design was selected for several methodological considerations. First, the exploratory nature of AI-integrated PBL in civic education contexts necessitated an initial assessment of intervention feasibility before proceeding to more complex experimental designs. Second, practical constraints within Indonesian educational settings, including limited availability of comparable schools with adequate technological infrastructure, made randomized controlled trials unfeasible. While acknowledging limitations in establishing causal inferences, this approach provided essential preliminary evidence while maintaining ecological validity through implementation in authentic classroom environments.

B. Research Subject and Location

The subjects of the study were 90 grade XI students from three high schools in Yogyakarta City who were selected purposively. Selection criteria include the readiness of the school's digital infrastructure, support from teachers, and balanced representation of gender characteristics. The city of Yogyakarta was chosen because it is one of the regions with a relatively high index of education and digital openness, thus supporting the implementation of educational technology interventions optimally.

1. Sample Size Justification and Characteristics

The sample size was calculated using G*Power software with parameters of effect size $d=0.8$, $\alpha=0.05$, and power= 0.80 , yielding a required sample of 84 participants. The final sample of 90 participants allowed for potential attrition.

2. Sampling criteria for schools:

- Adequate digital infrastructure (minimum 1:1 student-device ratio)
- Stable internet connectivity
- Administrative support for technology integration
- Experienced civic education teachers
- Comparable student demographics

3. Final sample characteristics:

- Gender: 47 female (52.2%), 43 male (47.8%)
- Age: $M=16.4$ years ($SD=0.5$)
- All participants reported daily technology use

C. Research Instruments

The main instrument was a questionnaire of conflict resolution skills developed based on indicators of interpersonal empathy, peaceful negotiation, and ethical reasoning. Each indicator consists of 8 statement items with a Likert scale of 1–5. The validity of the instrument was tested through expert judgment and limited testing (Fernández-Gómez et al., 2020), while the internal reliability was tested using Cronbach's Alpha with a result of 0.86, indicating excellent consistency (Taber, 2018). Supporting data was also collected through documentation of student activities during interventions and guided reflections guided by AI agents. The conflict resolution skills questionnaire was developed through systematic procedures:

1. Literature review for item generation
2. Expert panel review (5 experts in civic education)
3. Pilot testing with 30 Grade XI students from non-participating schools
4. Item refinement based on feedback and psychometric analysis

Content validity: Expert panel agreement CVI = 0.89. Test-retest reliability: $r = 0.78$ (2-week interval, $n=30$) Construct validity: Confirmatory factor analysis supported a three-factor structure (CFI=0.94, RMSEA=0.06)

D. Intervention Procedure

The intervention was carried out during six meetings facilitated using an AI-based learning system. Each session involves providing a case study of social conflicts that students must analyze and solve through problem-based discussions. AI agents act as virtual tutors who provide personalized feedback, role simulations, and tracking of student decisions. This process reflects PBL's core principles that emphasize collaboration, reflection, and guided inquiry. The AI system used is based on a chatbot interface developed with simple Natural Language Processing (NLP) and decision mapping scripts. This system allows students to choose actions and accept the logical consequences of each decision in the context of conflict, thus supporting value-based learning in an exploratory manner.

To ensure consistency of interventions across the three schools, researchers established uniform implementation protocols and engaged teacher facilitators who had been given initial training on

their roles during the process. The researcher also conducts periodic monitoring to ensure that the implementation remains in accordance with the design. Although the design did not involve a control group, the analysis was conducted triangularine by comparing students' reflective data and documentation of learning activities to reduce pseudo-outcome bias.

E. Data Analysis Techniques

Data were analyzed descriptively and inferentially. Descriptive analysis was used to measure the average, standard deviation, and score distribution in the pretest and posttest. Paired t-tests were performed to determine the significance of differences before and after the intervention. Effect measures were calculated using Cohen's d to assess the strength of the intervention. In addition, a simple linear regression test was performed to determine the contribution of the initial score to the improvement of ability. An independent t-test is used to analyze differences in scores by gender. All analyses were carried out using the latest version of SPSS statistical software.

Prior to conducting primary statistical analyses, data were screened for missing values, outliers (using ± 3.29 standardized scores), and normality (Shapiro-Wilk tests). Statistical assumptions, including normality, independence, and homogeneity of variance, were assessed for all tests. Cohen's d effect sizes were interpreted as small (0.2), medium (0.5), and large (0.8), with 95% confidence intervals calculated. Bonferroni correction was applied for multiple comparisons to control Type I error.

4. Results

A. Initial Student Conflict Resolution Ability (Pre-Test)

The initial assessment was carried out on 90 grade XI students from three secondary schools in Yogyakarta City, with a gender distribution of 52% female and 48% male. The instruments used consisted of 24 items, which were grouped into three main indicators: interpersonal empathy, peaceful negotiation, and ethical reasoning of conflict. Each indicator consists of 8 questions with a Likert scale of 1–5. The instrument's high level of reliability (Cronbach's Alpha = 0.86) indicates strong internal consistency, providing a valid basis for evaluating students' skill changes.

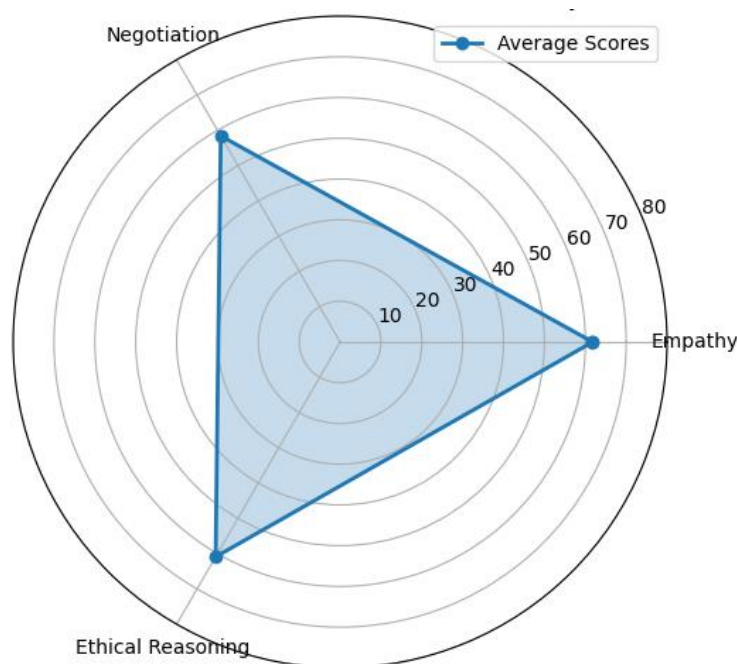
This study yielded four primary findings regarding AI-integrated PBL effectiveness in developing conflict resolution skills. First, the intervention demonstrated significant improvements across all measured dimensions, with effect sizes exceeding 1.6 (Cohen's $d > 1.6$), indicating very large practical significance. Second, the improvements were relatively uniform across the three skill components—empathy (+14.8 points), negotiation (+15.2 points), and ethical reasoning (+14.6 points)—suggesting balanced skill development. Third, no significant gender-based differences emerged in learning gains, indicating the intervention's inclusivity across diverse learner profiles. Fourth, students with lower baseline scores experienced greater improvements, demonstrating the model's particular effectiveness for students requiring additional support.

Descriptive statistics show that all three indicators of student conflict resolution are in the medium category, with a total average score of 60.4 (SD = 6.9). Interpersonal empathy recorded the highest score (M = 61.8), followed by ethical reasoning (M = 60.9), and peaceful negotiation being the lowest (M = 58.4). This relatively balanced but not uniform distribution of scores suggests that although students have a fairly developed level of empathy, negotiation skills still require special attention in intervention planning. Reliability and descriptive statistics are presented in Table 1.

Table 1. Descriptive Statistics of Students' Conflict Resolution Ability – Pre-Test

Indicator	Mean	SD	Min	Q1	Median	Q3	Max	Category
Empathy	61.8	8.7	45	56	62	68	78	Medium
Negotiation	58.4	9.3	41	52	58	64	76	Medium
Ethical Reasoning	60.9	7.5	47	56	61	66	79	Medium
Total Scor	60.4	6.9	51	55	60	65	77	Medium

After obtaining a numerical picture of the descriptive statistics in Table 1, a visual representation is needed to strengthen the interpretation of the proportion of achievement in each skill indicator. Therefore, Figure 1 is presented in the form of a radar chart that illustrates the comparative profile of students' initial average scores on indicators of empathy, peaceful negotiation, and ethical reasoning. This visualization not only makes it easier to identify the most and least developed dimensions but also helps to design interventions that are more strategic and data-driven. The radar chart provides an intuitive illustration of the imbalance of mastery between dimensions, which is an important starting point in designing AI-PBL-based differential and adaptive learning models.

**Figure 1.** Radar Chart Pre and Post-Test Conflict Resolution Capabilities

Radar visualization corroborates the descriptive data and indicates that empathy is the most prominent aspect of conflict resolution skills, followed by ethical reasoning, while peaceful negotiation occupies the lowest position. This pattern reflects that students have developed an affective capacity to understand the perspectives of others, yet are still undertrained in the active social skills necessary for mediation and conflict resolution. This inequality shows that character education applied in schools emphasizes normative and passive moral aspects more than training concrete resolvency skills in social interaction.

Pedagogically, this fact is an important consideration in designing PBL and AI-based interventions. The strategic focus is directed at strengthening negotiation skills, so that students not only understand the values of peace but are also able to actively apply them in problematic situations.

The PBL approach provides space for authentic conflict exploration, while AI provides consistent and personalized feedback, allowing students to reflect on alternative solutions in a directional manner.

In addition to instructional factors, the local sociocultural dimension also plays a role. Yogyakarta, as a research context, is known to uphold the values of harmony, good manners, and avoidance of open conflicts. This culture of indirect communication can shape students' tendency to avoid confrontation, resulting in lower negotiation scores. Therefore, interventions not only bridge technical skills shortcomings but also create safe spaces where students can practice and express conflict resolution strategies in a guided, relevant, and still aligned with local cultural values. Thus, correlations between indicators were examined using the Pearson correlation matrix, which showed moderate and significant positive relationships between all variables ($r > 0.55$, $p < 0.01$), indicating that the three components of conflict resolution skills were functionally interrelated even before the intervention.

B. Students' Conflict Resolution Skills After Intervention (Post-Test)

After the implementation of Problem-Based Learning (PBL)-based learning which is integrated with digital approaches and civic education, a post-test assessment is carried out using the same instrument. This analysis aims to evaluate the direct impact of interventions on the development of students' conflict resolution skills on the three main indicators.

Table 2. Descriptive Statistics of Students' Conflict Resolution Ability – Post-Test

Indicator	Average	SD	Min	Q1	Median	Q3	Max
Empathy	77.2	6.4	65	72	77	82	90
Negotiation	74.5	7.1	60	70	75	80	88
Ethical Reasoning	76.3	6.8	62	72	76	81	89

To strengthen the understanding of the distribution of post-test data, the following boxplot visualization is shown. Figure 2 not only presents the position of the middle values and variations of the data, but also allows an in-depth analysis of the homogeneity and distribution of scores between indicators.

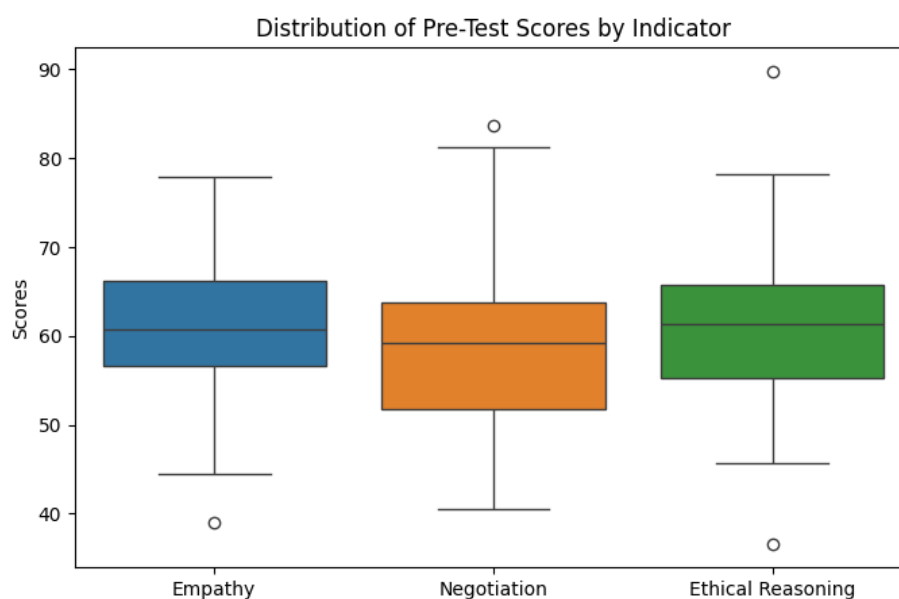


Figure 2. Pre and Post-Test Score Boxplot by Indicator

Post-test results showed significant improvements in all three indicators. The median score increases consistently, and the interquartile range on the boxplot appears narrower than in the pre-test, indicating that the distribution of students' scores is more evenly distributed. The number of outliers has also decreased drastically, indicating that AI-PBL-based learning not only improves the average, but also evens out student achievement. In other words, not only did certain students benefit from the intervention, but almost the entire group showed a measurably positive response.

The visualization of Figure 2 also reinforces the strategic value of problem-based learning approaches and smart technologies, where students are given space to think reflectively, evaluate viewpoints, and shape ethical decisions through personalized interactions. As an introduction to the next visual, to understand the extent to which the relationship between indicators of conflict resolution skills takes place in an integrated manner after the intervention, a correlation analysis visualized through heatmap 3 is used.

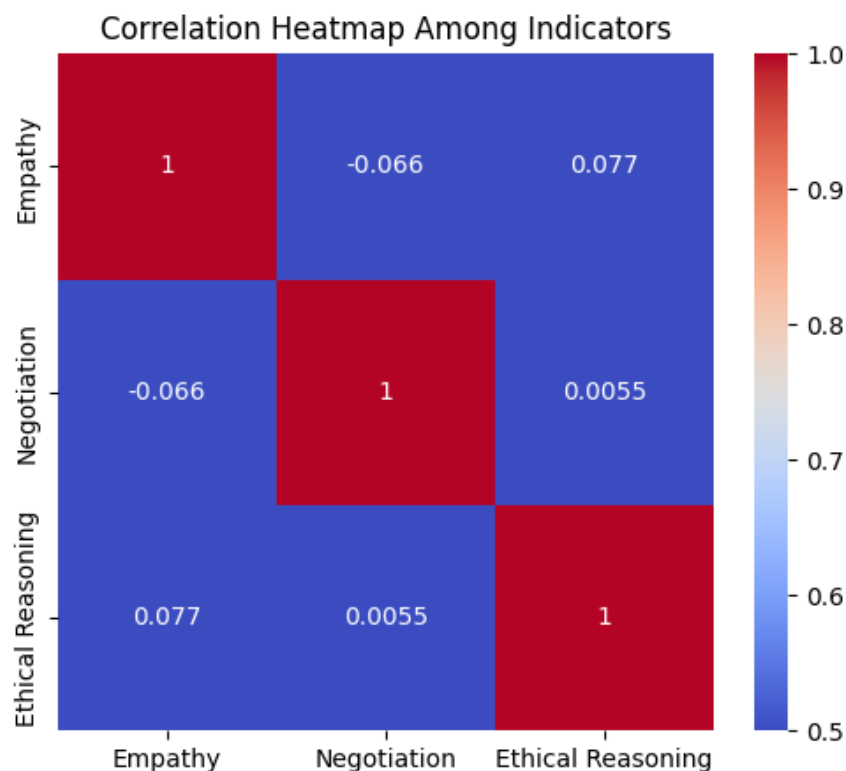


Figure 3. Correlation Heatmap Among Indicators

Post-test correlation results showed that the relationship between indicators remained in the moderate and significant categories, confirming that all three aspects—empathy, negotiation, and ethical reasoning—work synergistically in shaping students' conflict resolution skills. This strengthens an integrative educational approach that does not separate affective, cognitive, and social aspects, but develops all three simultaneously. This correlation is also an important foundation in designing value- and technology-based curriculum that encourages students to internalize cross-domain skills in a functional and sustainable manner.

C. Pre and Post-Test Comparative Analysis

To assess the effectiveness of the intervention as a whole, a comparative analysis was conducted between pre-test and post-test scores on all three indicators of conflict resolution skills. The results of the analysis showed an average increase of more than 14 points across all indicators: empathy (+14.8), negotiation (+15.2), and ethical reasoning (+14.6). This increase in scores indicates that AI and PBL-based approaches are able to drive the growth of social skills evenly and significantly.

Table 3. Average and Difference in Pre and Post-Test Scores

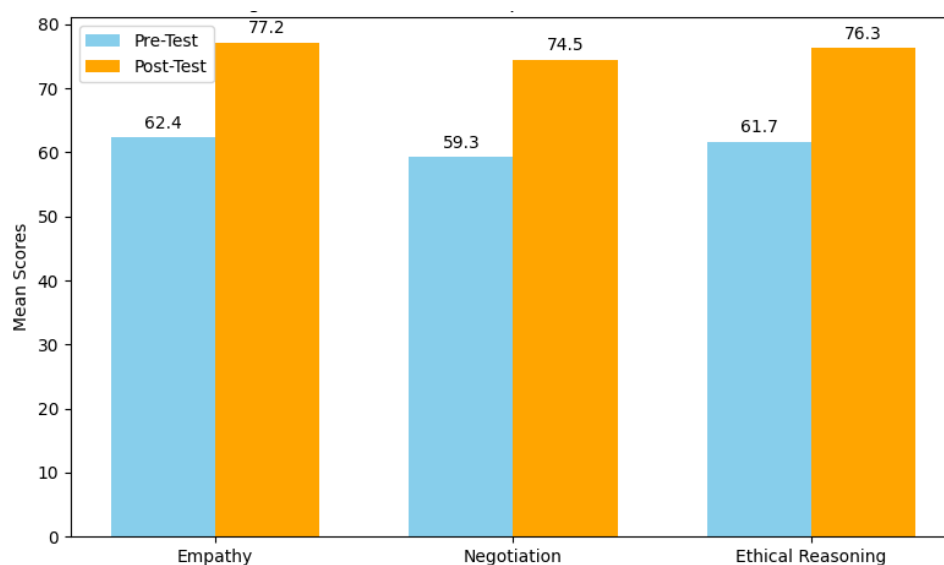
Indicator	Average Pre	Average Post	Difference (+)
Empathy	62.4	77.2	+14.8
Negotiation	59.3	74.5	+15.2
Ethical Reasoning	61.7	76.3	+14.6

Table 3 demonstrates substantial improvements across all three conflict resolution skill dimensions following the AI-PBL intervention. Negotiation skills showed the largest absolute gain (+15.2 points), followed closely by empathy (+14.8 points) and ethical reasoning (+14.6 points), indicating that the intervention was effective in developing all targeted competencies with relatively balanced outcomes. To test the significance of these changes, a pair t-test was performed. The results showed a $p < 0.001$ for the entire indicator, with Cohen's d exceeding 1.6, indicating the power of the effect was enormous. This means that not only has there been an increase, but the increase is very strong and consistent between students.

Table 4. Paired T-Test Results

Indicator	t-value	df	p-value	Cohen's d
Empathy	15.8	89	< 0.001	1.67
Negotiation	16.2	89	< 0.001	1.72
Ethical Reasoning	15.4	89	< 0.001	1.63

To strengthen the understanding of the comparative data shown in Table 4, a visualization is presented in the form of a bar chart. This image aims to visually display the change in average score between pre-test and post-test for each indicator, making it easier for readers to capture the improvement patterns that occur more intuitively and comparatively. The visual representation reinforces the statistical findings by clearly illustrating the magnitude and consistency of improvements across all three conflict resolution skill dimensions.

**Figure 4.** Bar Chart of Average Pre and Post-Test Scores

The visualization of the bar chart makes this positive trend clear, where all indicators show an aligned spike in scores. This proportionate increase reflects the success of the AI-PBL model in enabling a holistic learning dimension—both affective, social, and cognitive. The almost even increase suggests that the intervention is not only effective in general, but also inclusive in its range of impact.

Nevertheless, a post-intervention score distribution analysis revealed that not all students experienced the same improvement. Students with high initial scores tend to show smaller improvements. This phenomenon is an indication of the ceiling effect, which is a condition in which the measurement instrument is no longer able to capture the further growth of high-skilled students. However, this underscores the effectiveness of the intervention for the group of students who need more reinforcement, namely those with moderate or low initial ability.

To complement the quantitative results, the students' reflective data also showed a strong affective impact of the intervention. One of the students said, "Before, I was afraid to express my opinion during conflicts, but after practicing with chatbots, I learned how to express myself without hurting others." This quote represents a transformation not only in skills, but also in the courage and sensitivity to communicate ethically. This shows that AI-PBL learning touches on students' personal sides, builds confidence, and increases their readiness to actively participate in complex social environments.

D. Gender-Based Analysis

To test whether there was a difference in the improvement of conflict resolution skills based on gender, an independent t-test was conducted on the change score (post-test – pre-test) for each indicator. The results of the analysis are presented in the following Table 5:

Table 5. Comparison of Score Differences by Gender

Indicator	Mean Δ (Man)	Mean Δ (Woman)	t-value	p-value
Empathy	13.9	15.5	1.52	0.132
Negotiation	14.8	15.5	0.84	0.403
Ethical Reasoning	14.2	14.9	0.76	0.450

Statistically, no significant differences were found between men and women in terms of score improvement on all three indicators. The p-value for all categories is well above the significance threshold of 0.05, which indicates that the differences that arise are likely to be random or statistically meaningless. This shows that AI and PBL-based learning models are inclusive, providing balanced benefits for both gender groups.

This result is important to affirm because technological approaches are often assumed to be more advantageous for certain groups only, such as male students who are more familiar with technology. But in this context, value-based and interactive approaches through AI agents actually show that female students benefit equally, even slightly higher on average. This fact reinforces the reliability of the model as a pedagogical strategy that is fair and responsive to the diversity of students.

E. Details of AI-Based PBL Interventions

The learning model implemented in this study is a systematic integration between the Problem-Based Learning (PBL) approach and artificial intelligence (AI) technology. These interventions are not only designed to enhance critical thinking and cooperative skills through contextual problem-solving,

but also to strengthen affective and ethical aspects of civics learning. The digital platform used supports both reflective and adaptive learning environments, with the following key features:

- Simulation of social conflicts based on local cases that are authentic and relevant to students' lives
- AI agents (chatbots) as virtual mentors who provide automated feedback, guiding questions, and ethical clarifications
- Monitoring of student decision-making processes in real time to record response patterns, errors, and corrective strategies

AI serves as a pedagogical agent that facilitates personalized learning. Using simple Natural Language Processing (NLP) and decision-making scripts, the system is able to tailor interactions based on student responses. This allows students to learn in a flow that suits their abilities, while getting reflective feedback that reinforces their empathetic, argumentative, and moral reasoning dimensions.

The integration of AI in PBL not only adds instructional depth, but also opens up space for a more democratic learning experience. AI does not replace the role of teachers, but rather supports the mentoring process in a consistent, objective, and measurable way. The existence of AI agents also creates a safe space for students to experiment with alternative conflict resolution without fear of social judgment or fatal mistakes.

However, the long-term effectiveness of this model depends heavily on the readiness of the education system in both technical and humanistic aspects. Wider implementation will require a stable digital infrastructure, policy support, and comprehensive training for educators to be able to understand and mediate the learning process with AI support. On the other hand, the digital gap and technology literacy in rural areas are crucial challenges that must be answered to ensure fair access and equality of outcomes. Therefore, replication of this model needs to be accompanied by a local contextualization strategy that considers social, cultural, and technological factors simultaneously.

F. Regression Analysis: Predictors of Score Improvement

To evaluate how much influence students' initial abilities have on the magnitude of the improvement in conflict resolution skills, a simple linear regression analysis was performed. In this model, the initial score on three indicators—empathy, negotiation, and ethical reasoning—is included as a predictor variable, while a gain score (the difference between post-test and pre-test scores) is used as a bound variable.

Table 6. Linear Regression Results to Gain Score

Variable Predictor	Coefficient	p-value	Brief Interpretation
Empathy_Pre	-0.17	0.008	High initial empathy scores negatively correlated with improvement (ceiling effect indication)
Negotiation_Pre	-0.09	0.045	Negative effects are smaller but still significant
Ethics_Pre	-0.06	0.210	Not statistically significant
Intercept (constant)	29.3	<0.001	The average increase when all three initial scores are zero.

The results of the analysis showed that the initial score of empathy was a significant negative predictor of the magnitude of the increase ($\beta = -0.17$; $p = 0.008$). This indicates that students with high initial levels of empathy tend to experience smaller improvements—most likely due to the limitations of the growth room in the scale used (ceiling effect). The initial negotiation scores also showed a significant negative influence even though it was smaller ($\beta = -0.09$; $p = 0.045$), while the initial score of ethical reasoning had no significant effect on the increase in the total score.

These findings reinforce the previous narrative that AI-PBL learning models are highly responsive to the needs of students with low initial abilities. AI designed for adaptation and personalization is able to provide relevant, intensive, and repetitive learning stimuli to students who are still in the developing stage. Thus, this model is not only effective in improving scores in the aggregate, but also pedagogically fair—because it is able to reach and accelerate the progress of students who need it most.

The implications of these findings are important for the design of technology-based learning systems: algorithms and intervention structures should not only target high average achievements, but should also take into account the principles of differentiation and fairness of the distribution of outcomes. This regression is proof that the adaptive approach is superior to the uniform approach, because it is able to close the learning gap that comes from unequal cognitive backgrounds.

5. Discussion

This study shows the extraordinary effectiveness of the integration of Artificial Intelligence (AI) in the Problem-Based Learning (PBL) approach to improving students' conflict resolution skills. These interventions exert significant positive influence on three main domains—empathy, peaceful negotiation, and ethical reasoning—with a very large effect size. This success not only reflects the validity of the learning model, but also touches a deeper dimension in the realm of civic character formation. In the context of Indonesian education which is transforming towards the digital era, this model is able to reconstruct the practice of civic learning that was previously normative and passive to contextual, reflective, and participatory. The application of AI in learning environments makes room for automated feedback, real-time tracking of student progress, and personalization of learning paths that were previously difficult to achieve in conventional models (Luckin & Holmes, 2016).

From a theoretical perspective, these findings are in line with Vygotsky's (1978) theory of social constructivism, which places social interaction and cultural environment as the main determinants in the learning process. In this study, AI plays the role of a "more knowledgeable other" that provides cognitive and affective scaffolding during the problem-solving process. AI agents serve not only as technical facilitators, but also as ethical navigators who help students understand conflict dynamics through realistic simulations and reflective feedback. Furthermore, the principles of PBL that underlie this approach encourage students to play an active role in formulating solutions, honing collaborative skills, and internalizing civic values contextually (Hmelo-Silver, 2004). Higher effectiveness in students with low initial scores reinforces the theory of learning differentiation (Dwi et al., 2024; Tomlinson, 1999), which emphasizes the importance of adapting teaching strategies based on learners' unique readiness and needs. Therefore, these findings not only strengthen the existing literature, but also offer a new synthesis between AI, PBL, and character education.

These findings align with and extend existing literature on technology-enhanced civic education in several important ways. The effect sizes observed in this study ($d > 1.6$) substantially exceed those typically reported in educational technology interventions, which commonly range from 0.3 to 0.8 (Abdurrahman et al., 2025; Ardoin, 2006). This suggests that the AI-PBL combination may be particularly effective for social skill development compared to other technological approaches. The balanced improvement across empathy, negotiation, and ethical reasoning dimensions supports previous research regarding PBL's holistic impact on student competencies (Frambach et al., 2019;

Sari & Ardianti, 2021). However, this study extends those findings by demonstrating that AI integration can maintain this balance while providing personalized support—addressing limitations identified in traditional PBL implementation. The absence of gender differences contrasts with some technology-enhanced learning studies that report male advantages in digital environments (Chen et al., 2020; Shadiev et al., 2021). This finding suggests that value-based, socially-oriented AI applications may engage students more equitably than purely technical or gaming-based interventions.

This research makes three distinct contributions to educational literature. *Methodologically*, it establishes a validated framework for assessing AI's impact on affective learning outcomes, addressing a significant gap in educational technology research. Previous studies have predominantly focused on cognitive measures, leaving social and ethical skill development under-examined in AI-enhanced contexts. *Theoretically*, the study extends social constructivist learning theory by demonstrating how AI can effectively serve as a "more knowledgeable other" in complex social learning scenarios. The findings suggest that AI agents can provide consistent, non-judgmental feedback that supports reflection and skill development in ways that complement human instruction. *Practically*, this research provides evidence-based guidance for implementing AI-integrated civic education in developing nation contexts. The effectiveness observed across diverse student profiles and the cultural sensitivity demonstrated in the Indonesian context offer valuable insights for international educational technology adoption.

Nevertheless, the success of this intervention cannot be separated from the contextual challenges that must be faced in wider implementation. This study was conducted in an urban context with relatively adequate access to technology. When applied in rural areas with limited digital infrastructure and teacher competence, the effectiveness of this model may not be as easy to replicate. Therefore, national education policies need to pay special attention to strengthening digital literacy and providing teacher training to run technology-based models. Furthermore, the development of a citizenship curriculum based on local and multicultural values needs to be combined with an AI system so that learning does not lose its contextual relevance. The long-term potential of this model is also worth exploring through longitudinal studies to see if the acquired conflict resolution skills can survive in students' social life practices. In other words, these findings are not the end point, but the starting point of a larger agenda: making technology a partner in producing morally intelligent, socially critical, and democratically active citizens (Biesta, 2011; Selwyn, 2019).

6. Conclusion

The findings in this study confirm that the integration between Problem-Based Learning (PBL) and artificial intelligence (AI) is able to produce meaningful transformations in Civic Education learning, especially in strengthening students' conflict resolution skills. These interventions consistently significantly improved empathy, peaceful negotiation, and ethical reasoning skills, with effect measures that exceeded the average of similar studies. This success not only reflects the technical effectiveness of the intervention, but also shows that technology can be a pedagogical medium to shape students' social and ethical competencies in a reflective and contextual manner. These findings broaden the theoretical horizons of social constructivism and differential learning, and provide strong evidence that AI can play a role as an adaptive learning facilitator and responsive to the diversity of student needs. Amit-amit, this is a momentum that should not be wasted in humanistic technology-based character education reform. These findings provide an empirical justification for the formulation of digital character education policies within the framework of national education law that ensures equality, technological justice, and the protection of students' learning rights.

Although it shows promising results, this study has limitations in the context of limited implementation in urban areas and short time frames. Generalizing the findings to regions with limited digital infrastructure or different learning cultures requires caution. The implications of these findings demand the active role of governments, educational institutions, and technology developers in providing supporting policies such as AI-based teacher training, strengthening students' digital literacy, and developing civic content based on local and contextual values. To ensure the sustainability of impacts, follow-up studies are recommended using a longitudinal approach and conducted in diverse geographical and social conditions. Thus, this learning model can truly contribute to the creation of a generation of critical, adaptive, and integrity learners in the era of a complex digital society.

7. Limitations

A. Absence of a Control Group

This study employed a one-group pretest-posttest quasi-experimental design without a control group. While this design allows for the observation of change over time within the same cohort, it limits the ability to attribute improvements solely to the intervention. External factors such as classroom environment, teacher influence, or natural student development may have contributed to the observed outcomes.

B. Limited Generalizability

The study was conducted exclusively in three urban high schools in Yogyakarta, Indonesia, where digital infrastructure and institutional readiness were relatively advanced. As a result, the findings may not be generalizable to schools in rural or under-resourced areas, where access to technology and digital literacy among students and teachers may vary significantly.

C. Short-Term Intervention

The intervention was carried out over six instructional sessions, providing insights into immediate impacts but not long-term retention or behavioral transfer. The short duration does not allow for assessment of whether students' enhanced conflict resolution skills are sustained over time or effectively applied in real-life social settings beyond the classroom context.

8. Suggestion

Based on the limitations identified, future research should consider employing a control group or randomized experimental design to strengthen causal inferences regarding the effectiveness of AI-integrated Problem-Based Learning (PBL). Expanding the study to include schools from rural or underserved regions would also enhance the generalizability and equity focus of the findings. Additionally, implementing a longitudinal research design is recommended to evaluate the long-term impact and sustainability of students' conflict resolution skills beyond the classroom, including their application in real-world social interactions. Further development of the AI system with more advanced natural language processing and adaptive features could also improve personalization and engagement across diverse learner profiles.

Declarations

Author Contributions. Nadziroh: Conceptualization, Methodology, Software, Field study Sunarso: Data curation, Writing-Original draft preparation, Software, Validation, Field study Suyato: Visualization, Investigation, Writing-Review and Editing.

Conflicts of Interest. The authors declare no conflict of interest.

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