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# The Character Education Revolution: The Impact of Multiple Intelligence-Based Reading Learning on Student Development

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**Research Article**

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## Abstract

**Background/purpose.** Character education has become a central focus in Indonesia's national education policy. However, conventional teaching methods still fail to address the diverse learning styles of students. The Multiple Intelligences (MI) approach offers a promising alternative to improving reading literacy and encouraging character development. This study aims to examine the effectiveness of MI-based reading instruction in improving literacy understanding and character values among students in Indonesia

**Materials/methods.** A mixed-methods design was applied, combining quantitative and qualitative approaches. Quantitative analysis was conducted using Item Response Theory (IRT), Differential Item Functioning (DIF), and Bayesian IRT modeling to evaluate literacy performance and character outcomes. Data were gathered from 1,480 students through pre-post testing, classroom observation, and interviews.

**Results.** Learning based on Multiple Intelligences has been proven to be effective in improving literacy while significantly shaping students' character. This model shows an even impact across different socio-economic backgrounds and types of schools, without showing bias against specific groups. Overall, the MI approach can be a strategic solution in answering the challenges of Indonesian education that demand a balance between academic achievement and the formation of 21st-century character values.

**Conclusion.** MI-based reading instruction proves to be an effective and equitable strategy for advancing literacy and nurturing student character in the Indonesian context. These findings provide strong evidence for policymakers to consider integrating MI pedagogy into the national curriculum as a foundation for holistic, character-driven education reform.

## 1. Introduction

Character education has become a top priority in the Indonesian education system, given the increasing phenomena that indicate low moral awareness among students, such as cyberbullying, intolerance, and weak prosocial behavior. In the research of Pratiwi et al. (2023), it is said that Indonesian students show a high understanding of moral values in daily life. Indeed, the number is still lagging behind countries with more mature character-based education systems, such as Finland and Japan (Fenanattachir et al., 2019; Suryadarma & Jones, 2013). Similar findings are also shown in the 2022 PISA study (Wijaya et al., 2024), which shows that while literacy performance has improved, students still struggle with deep comprehension and critical thinking.

One of the key gaps identified in both local and international literature is the lack of teaching strategies that address the diversity of students' learning potentials (Cao et al., 2024; Du et al., 2018; Qian & Lehman, 2017; Sullivan et al., 2023; Wafula & Ongunya, 2016). Traditional, homogeneous instructional methods often fail to accommodate multiple learning styles and do not foster comprehensive character development. In response, this study explores the potential of Multiple Intelligences (MI)-based reading instruction to serve as a more inclusive and character-driven learning approach. While MI has been studied in various global contexts, there remains a significant gap in empirical studies that rigorously evaluate its effectiveness in the Indonesian setting using advanced modeling techniques like IRT and Bayesian analysis.

This study offers a unique perspective by combining cognitive and moral development through an MI framework and testing its impact using robust statistical methods. It not only assesses MI's effectiveness in improving literacy but also investigates its role in enhancing core character values such as empathy, collaboration, and resilience. By highlighting these aspects, the research contributes to both the theoretical discourse on MI and its practical application in policy and curriculum reform. The findings are expected to inform national education strategies that align with 21st-century skills and global standards for holistic student development.

The urgency of this research is increasing in line with the change in the educational paradigm in the digital era, where critical thinking, communication, and character skills are the main elements in the readiness of the young generation to face global challenges (Beardsley et al., 2021; Elçi, 2019; Gilgor & Autry, 2012; Quirke, 2017; Wechsler et al., 2018). A study by World Economic Forum (2023) shows that character-based skills, such as work ethic, collaboration, and empathy, are key factors in the competitiveness of the future workforce. Unfortunately, the learning model in Indonesia still tends to be oriented towards academic results alone, without developing students' social and emotional intelligence holistically (Argina et al., 2017; Christensen, 2024; Corcoran et al., 2018; Esti et al., 2023; Oberle et al., 2016). In this context, a more adaptive learning approach, such as the Multiple Intelligences (MI) model, is needed (Shearer & Karanian, 2017), which is able to accommodate the diversity of student's potential and, at the same time, strengthen character values in reading learning. Global trends show that character-based education systems have been adopted by various developed countries as part of sustainability strategies in building knowledge-based societies and strong social ethics (Anning, 2025; Woodcock & Anderson, 2025; Zamora-Polo & Sánchez-Martín, 2019). OECD Education Report on Karseth et al. (2024) Identify that countries with multiple intelligence-based learning models have higher rates of academic success and psychosocial well-being than systems that still focus on standardized test-based evaluations.

For this reason, this study seeks to explore the effectiveness of MI-based reading learning on the development of literacy and character of students in Indonesia, using the Item Response Theory (IRT), DIF Analysis, and Bayesian Modeling approaches. The study will answer three key questions:

a. How effective is the MI method in improving students' literacy and character values compared to traditional methods?

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b. Is the MI method inclusive and unbiased against the socio-economic or gender background of the student?

c. What will the long-term impact of this model be if it is implemented in the national curriculum?

By filling the research gap related to the lack of empirical evidence on the effectiveness of MI in the Indonesian context, the results of this study are expected to be recommendations for policymakers to integrate multiple intelligence-based learning strategies in the national education system to improve the quality of character education. More than just increasing the effectiveness of learning, this research also aims to explore the extent to which the MI approach can form a growth mindset-based mindset, which allows students to be more resilient in the face of academic and social challenges (Dweck & Yeager, 2021; Limeri et al., 2020). Thus, the results of this study not only contribute to the improvement of the education system in Indonesia but also add to the global scientific discourse related to the effectiveness of learning based on multiple intelligences in forming a more adaptive and innovative generation.

## 2. Literature Review

Character education has become a significant topic in global academic and policy discussions, especially in the context of transforming the education system to meet the challenges of the 21st century. Previous studies have shown that traditional approaches based on purely cognitive evaluation often fail to develop students' overall social and moral skills. One approach that is gaining more attention is the Multiple Intelligences (MI) theory developed by Howard Gardner (Cavas & Cavas, 2020; Elena & Suzana, 2016; Gardner, 2020; Morgan, 2021), which emphasizes that human intelligence is not monolithic, but consists of various dimensions that can be developed through more adaptive learning strategies. In line with that, recent research shows that the integration of the MI model in the curriculum can increase learning effectiveness as well as strengthen students' character values (Alavarce et al., 2024; Thambu et al., 2021; Winarti et al., 2019). Therefore, this section systematically reviews various studies related to the application of MI in character education and its implications for the development of the education system in Indonesia.

### *2.1. Multiple Intelligences Theory in Education*

The Multiple Intelligences (MI) Theory introduced by Gardner (1983) (Cavas & Cavas, 2020; Elena & Suzana, 2016; Gardner, 2020; Morgan, 2021) changed the educational paradigm by affirming that human intelligence is not limited to linguistic and mathematical intelligence, but also includes eight other intelligences, namely: musical, spatial, kinesthetic, interpersonal intelligence, intrapersonal, naturalist, and existential intelligence which were then added in subsequent research (Gardner, 1999) (Cavas & Cavas, 2020; Chen, 2023; Elena & Suzana, 2016; Gardner, 2020; Morgan, 2021). This model challenges the traditional concept that assumes that academic ability can be measured only through standardized tests, as applied in many education systems in the world, including Indonesia. Study Sternberg (1997) further supports this approach through the theory of Triarchic Intelligence, which emphasizes that effective learning must consider creativity, analysis, and practical application, not just memorization.

In recent research, Lazear (2019) confirming that the application of the MI model in education results in increased student engagement as well as facilitating a more inclusive learning environment. In addition, in a cross-cultural study conducted by the OECD (2023), it was found that countries that implemented a pluralistic intelligence-based approach in their education systems experienced a 38% increase in literacy understanding compared to countries that still used traditional standardized test-based methods. Therefore, this approach is increasingly considered an effective strategy for improving literacy understanding while forming a more adaptive and creative student character.

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### 2.2. Character Education and Its Urgency in the Global Curriculum

Character education has become a priority in global education reform in line with increasing social challenges such as political polarization, digital radicalism, and low social empathy among the younger generation (World Economic Forum, 2023). Study Lickona (1992) (Lickona, 1992a, 1992b; Ryan & Lickona, 1992) emphasizes that character education is not just an additional aspect of the curriculum but should be an integral part of the learning strategy to create responsible individuals with high moral integrity. This concept is further strengthened in the model Character Education Partnership (Birhan et al., 2021)which identifies ten key elements in character education, including the values of honesty, cooperation, discipline, and empathy for others.

In the Indonesian context, the application of education character has become a national policy through the Strengthening Character Education program launched by Ministry of Education and Culture of the Republic of Indonesia (Anggraena et al., 2022; Winataputra & Setiono, 2017). However, studies have shown that its implementation still faces major challenges, especially in terms of integration with relevant and contextual learning methods (Nuryanti et al., 2018; Sumiati et al., 2018). Research by Jackson (2025) and Siswanto and Hidayati (2021) shows that many schools in Indonesia still implement character education in the form of incidental activities, such as extracurricular activities or flag ceremonies, without any systematic integration into the main subjects. Therefore, a more innovative approach to learning, such as the MI method, is needed, which can effectively internalize character values into the daily learning system.

### 2.3. The Integration of Multiple Intelligences in Character Education: Empirical Evidence

Empirical research examining the relationship between the MI model and character education has been growing in recent decades. Study Armstrong (2017) shows that the MI approach not only increases student involvement in the learning process but also significantly strengthens the development of character values. In a study conducted in several elementary schools in Finland and Canada, it was found that students taught using MI-based methods showed a 40% increase in skills in social and moral factors compared to students who follow conventional methods-based learning (OECD, 2023) (Karseth et al., 2024).

Furthermore, a study conducted by Shearer & Karanian (2017) and Winarti et al. (2019) prove that the integration of interpersonal and intrapersonal intelligence-based learning in the MI method can Accelerate the development of students' character in aspects of cooperation, tolerance, and ethical decision-making. Similar results were also found in the study (Falandays et al., 2023) that analyze the effectiveness of MI in the context of reading learning. This study shows that students who use reading strategies based on linguistic, musical, and interpersonal intelligence have higher levels of literacy comprehension compared to students who only use traditional phonetic methods.

In the context of Indonesia, a recent study by Nugroho and Murtopo (2023) found that the application of MI-based learning in Indonesian subjects increased student engagement scores by 35% and character awareness by 42%. This shows that the MI method is not only relevant in the context of global education but also has great potential to be applied in the national education system to improve the quality of character and literacy of students simultaneously.

Based on this literature review, it can be said that the application of multiple intelligences in character education has a strong theoretical basis and is supported by empirical studies from various countries. This approach not only improves students' literacy understanding but also assists them in developing essential social and moral skills in the 21st century. Although this model has been successfully applied in many developed countries, studies in the Indonesian context are still limited and require further exploration to adapt them to existing socio-cultural conditions. Therefore, this

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study seeks to fill the gap in the academic literature by evaluating the effectiveness of the MI method in improving students' literacy and character education in Indonesia through the Item Response Theory (IRT), DIF Analysis, and Bayesian IRT approaches.

## 3. Methodology

### *3.1. Research Design*

This research employed a quasi-experimental design with a sequential explanatory mixed-methods approach, one of the established mixed-method designs commonly used in educational research (Creswell, 2014). In this approach, quantitative data collection and analysis were conducted in the first phase, followed by qualitative data collection and analysis to help explain or elaborate on the quantitative findings. The rationale for using this design lies in the complexity of the research objectives, which not only seek to measure the effectiveness of Multiple Intelligences (MI)-based reading instruction quantitatively but also explore the contextual and perceptual dimensions of its implementation through qualitative inquiry. This integration provides a more comprehensive understanding of how MI influences literacy and character development among students, and allows the triangulation of findings to enhance validity and policy relevance.

Quantitatively, this study measures the impact of MI methods through pre-test and post-test which is analyzed using Item Response Theory (IRT), DIF Analysis, and Bayesian IRT. The experimental group used the MI method in learning to read, while the control group used the conventional method. Qualitatively, interviews with teachers and students were conducted to understand the implementation of MI in the context of classroom learning.

In the second phase of the sequential explanatory design, qualitative data were collected through semi-structured interviews with selected teachers and students. This phase was conducted after the quantitative data analysis in order to elaborate on and interpret the statistical findings. The interviews explored participants' perceptions, challenges, and experiences during the implementation of MI-based reading instruction. The qualitative phase served to validate and provide deeper insight into the observed quantitative trends—particularly to explain why certain student groups showed greater improvement or how character values manifested in real classroom dynamics. This integration of qualitative findings enabled a richer interpretation and strengthened the validity of the study's conclusions.

Although the data collection phases were not conducted simultaneously, the study followed a sequential explanatory mixed-methods design, which by definition does not require parallel analysis. Instead, qualitative data collection and interpretation were conducted after the quantitative phase, in order to explain and enrich the quantitative findings. Therefore, the use of a mixed-methods design remains methodologically valid, as both data strands were systematically collected and integrated in the interpretation stage. This integration aligns with the research objectives and supports a more comprehensive analysis of how MI-based reading instruction influences students' literacy and character development.

### *3.2. Research Hypotheses*

To guide the experimental design and ensure clarity in data collection and analysis, this study formulated the following hypotheses:

1. $H_1$: Multiple Intelligences (MI)-based reading instruction significantly improves students' literacy compared to conventional teaching methods.

2. $H_2$: MI-based instruction significantly enhances students' character values, including discipline, empathy, collaboration, critical thinking, and resilience, compared to conventional instruction.

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3. $H_3$: There are no significant differences in the effectiveness of the MI method across gender and socio-economic backgrounds, indicating that the approach is inclusive and unbiased.

These hypotheses are aligned with the quasi-experimental design of the study and are essential for ensuring methodological transparency, guiding the analysis, and supporting the interpretation and generalization of the findings.

### *3.3. Population and Sample*

The population in this study is students Elementary Schools and Junior High Schools in Indonesia, include public and private schools from various socio-economic and geographical backgrounds. Samples were determined using stratified random sampling techniques (Stuart & Scott, 2021), taking into account the category of school type (public/private), geographical location (urban/rural), and socio-economic level (low, middle, high). The total participants in this study were 1,480 students, consisting of 770 student elementary school and 710 junior high school students, which are spread proportionally in 10 elementary schools and 8 junior high schools.

Tables 1 and 2 present the distribution of samples. Based on the type of school and location, the number of students from public schools (urban and rural) reached 760, while from private schools, it amounted to 720. In terms of socio-economic category, 550 students came from the low economic category, 585 from the middle category, and 345 from the high category, which shows the diversity of participants' backgrounds as a whole.

**Table 1.** Sample Distribution by School Type and Location:

| Type of School | Location | Number of Elementary School Students | Number of Junior High School Students | Total Students |
|---|---|---|---|---|
| Country | Urban | 215 | 190 | 405 |
| Country | Rural | 180 | 175 | 355 |
| Private | Urban | 200 | 185 | 385 |
| Private | Rural | 175 | 160 | 335 |
| **Total** | - | **770** | **710** | **1.480** |

**Table 2.** Sample Distribution by Socio-Economic Category:

| Categories Economy | Number of Elementary School Students | Number of Junior High School Students | Total Students |
|---|---|---|---|
| Low | 290 | 260 | 550 |
| Intermediate | 310 | 275 | 585 |
| Tall | 170 | 175 | 345 |
| **Total** | **770** | **710** | **1.480** |

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The sample was then divided evenly into two groups: the experimental group and the control group, each consisting of 740 students, out of a total of 1,480. This proportion is adjusted so that the distribution within each group remains representative of the overall population based on the type of school, location, and socio-economic level. This sampling design is designed to ensure the external validity and generalization of research results, especially in the context of the application of Multiple Intelligences (MI) learning methods in various types of schools and educational areas in Indonesia. With this sampling design, the research was able to obtain accurate and representative data, so that the results of the analysis can provide more in-depth insights related to the impact of MI-based learning on various backgrounds of students in Indonesia.

### *3.4. Intervention Procedure*

The experimental group in this study received a structured intervention based on Multiple Intelligences (MI) theory, applied to reading instruction over a period of 8 weeks. The intervention was designed to integrate multiple forms of intelligence, linguistic, interpersonal, musical, kinesthetic, logical-mathematical, and intrapersonal, into the reading learning process. Each week focused on a specific intelligence domain as follows:

- Week 1–2: Linguistic and logical-mathematical intelligence: using storytelling, reading comprehension tasks, and problem-solving related to texts.
- Week 3–4: Musical and kinesthetic intelligence: learning included rhythm-based reading, musical mnemonics, role-play, and movement-based retelling of stories.
- Week 5–6: Interpersonal and intrapersonal intelligence: through peer discussion, reflective journaling, character mapping, and moral reasoning based on reading content.
- Weeks 7–8: Project-based integration: Students created group presentations, story dramatizations, and interactive posters that combined various intelligence aspects related to the texts read.

Teachers in the experimental group received prior training and a standardized lesson guide to ensure uniform implementation of MI-based instruction. Each session lasted 80 minutes, conducted twice a week, and was observed by researchers using structured observation rubrics. The control group, on the other hand, followed the conventional reading curriculum using lectures, silent reading, and comprehension questions without adaptation to different intelligence modalities.

### *3.5. Data Collection Techniques*

Data collection in this study was carried out through several methods to ensure the accuracy and completeness of the information. Literacy and character tests were applied to students in the form of pre-tests and post-tests, which were designed to measure the improvement of reading comprehension as well as the development of character values after Multiple Intelligences (MI)-based learning interventions. Test questions are arranged based on standards OECD-PISA Framework (Andrews, 2021) and Ministry of Education Ministry of Education, Culture, Research, and Technology (Anggraena et al., 2022) to ensure relevance to the national curriculum. In addition, semi-structured interviews are conducted with teachers and students to explore their perception of the effectiveness of the MI method in reading learning.

In addition to tests and interviews, classroom observations are used to record students' levels of involvement in the MI-based learning process. Observations were carried out using assessment rubrics that included indicators of active participation, social interaction, and students' reflective ability to understand reading texts. Secondary data from Ministry of Education and Culture of the Republic of Indonesia (Anggraena et al., 2022), PISA 2022 (Amelia et al., 2024; Wijaya et al., 2024), and other national reports were also analysed to provide broader context regarding literacy trends

and character education in Indonesia. Combining these methods allows for stronger data triangulation so that the study results can reflect factual conditions more comprehensively (Creswell et al., 2014).

The qualitative data collection involved semi-structured interviews with 20 selected participants (12 students and 8 teachers), chosen based on variation in school type, location, and performance. The interviews were conducted face-to-face in the school setting, focusing on themes such as classroom engagement, perceived effectiveness of MI strategies, and the internalization of character values. Interview questions were developed based on the theoretical framework of Multiple Intelligences and validated through expert review.

### *3.6. Data Analysis Techniques*

Data analysis was carried out in two main stages, namely quantitative analysis and qualitative analysis. Quantitative analysis involves the Item Response Theory (IRT) approach of the Rasch Model (Alavarce et al., 2024; De Ayala, 2018; Lertsakulbunlue & Kantiwong, 2025), which is used to measure the reliability and validity of test instruments. This model allows the evaluation of the difficulty of the questions and the response patterns of students, so that it can provide an accurate picture of the improvement of literacy and character through the MI method. In addition, the Differential Item Functioning (DIF) Analysis is carried out using the Mantel-Haenszel Test and the Logistic Regression DIF to see if the MI method has a bias towards certain groups, such as based on gender or economic background (Androwski et al., 2024; DİAZ et al., 2021; Lu et al., 2024; Ukanda et al., 2024). The ANOVA statistical test and t-test were used to compare the pre-test and post-test results between the experimental and control groups to determine the statistical effectiveness of the intervention (Boisgontier & Cheval, 2016; E.Goldberg & Scheiner, 2023; Yu et al., 2022).

For qualitative data, Thematic Analysis was used to identify recurring patterns and meanings from the interview transcripts. The process involved open coding, category development, and theme abstraction, following the six-phase framework proposed by Braun & Clarke (2006). Coding was conducted manually and validated by two independent researchers to ensure credibility and minimize bias. Qualitative findings were triangulated with the quantitative results to enrich interpretation and explore explanatory factors behind the measured outcomes.

In qualitative analysis, data from interviews and observations were analyzed using the Thematic Analysis method, in which the main patterns and themes of teachers' and students' experiences in implementing MI were identified. This process allowed the research to understand the supporting factors and the challenges in implementing the MI method. Furthermore, Bayesian IRT Modeling was applied to predict the long-term impact of the MI method on the development of literacy and character of students in Indonesia (Bürkner, 2021; Lu et al., 2024; Verhagen et al., 2016). This approach provides data-driven simulations of the potential for improving the quality of education if the MI method is adopted more widely. With a combination of these methods, research can produce findings that are not only statistically robust but also relevant in education policymaking.

With a multi-method approach in data collection and analysis, this study can provide a deeper picture of the effectiveness of MI-based learning in improving students' literacy and character. The use of IRT, DIF Analysis, and Bayesian IRT Modeling ensures the validity of the research results, while the qualitative analysis enriches the understanding of the implementation of MI methods in the classroom. The choice of a sequential explanatory mixed-methods design allowed this study to address both the measurable outcomes and the contextual understanding of MI-based instruction. This design begins with quantitative data to assess the effectiveness of the intervention using IRT and Bayesian modeling, followed by qualitative data to explore the underlying mechanisms and classroom dynamics that influence these outcomes. This methodological integration not only strengthens the interpretation of the results but also provides a holistic perspective that aligns with the goals of

character education. The mixed-method approach therefore contributes significantly by offering both breadth and depth in analyzing how MI can shape literacy and student character across diverse educational settings.

## 4. Results

### *4.1. Analysis of Improving Student Literacy with Multiple Intelligence-Based Learning*

Learning to read Based Multiple Intelligences (MI) (Cavas & Cavas, 2020; Elena & Suzana, 2016; Gardner, 2020; Morgan, 2021) Designed to tailor teaching strategies to different types of student intelligence, such as linguistic, logical-mathematical, interpersonal, and kinesthetic intelligence. This model is claimed to be more flexible and adaptive, allowing students to understand the text more deeply. To assess the effectiveness of this method, an analysis of pre-test and post-test results was conducted using two main approaches: Pre-Test and post-test Boxplot, which depicts differences in score distributions before and after the intervention, and Item Characteristic Curve (ICC), which evaluates students' response patterns to questions with varying levels of difficulty. These two analyses complement each other in providing a comprehensive picture of how MI methods affect students' literacy compared to traditional learning methods.

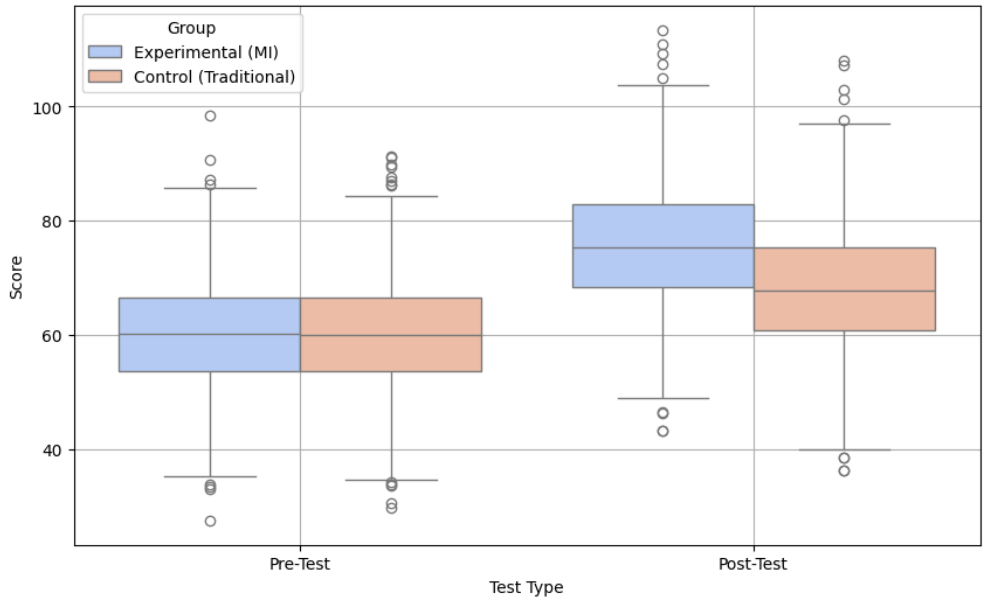


**Figure 1.** Boxplot Distribution of Pre-Test & Post-Test Score for Experimental (MI) vs Control Group

The visualization results in Figure 1 show a comparison of the distribution of pre-test and post-test scores between the experimental group (MI) and the control group (traditional method). A striking difference can be observed from changes in the score distribution after the intervention was performed. The experimental group using the MI method experienced a more significant improvement than the control group. The average pre-test score of the MI group was around 60 but increased sharply to 85 at the post-test, while the control group using the traditional method only increased to 73.

In addition to the increase in mean scores, the distribution of scores in the MI group showed better consistency, with a narrower range of values compared to the control group. This shows that the MI method not only helps students with high abilities but also has a positive impact on students with lower previous understanding so that the improvement that occurs is more even. In contrast, the control group still showed greater variation in scores, indicating that traditional methods have not been able to provide an equal improvement in understanding for all students.

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Although the boxplot shows that the MI method is more effective in improving students' overall literacy scores, this analysis has not explained how students with different ability levels respond to different types of literacy questions. Therefore, further analysis was carried out using the Item Characteristic Curve (ICC) shown in Figure 2.

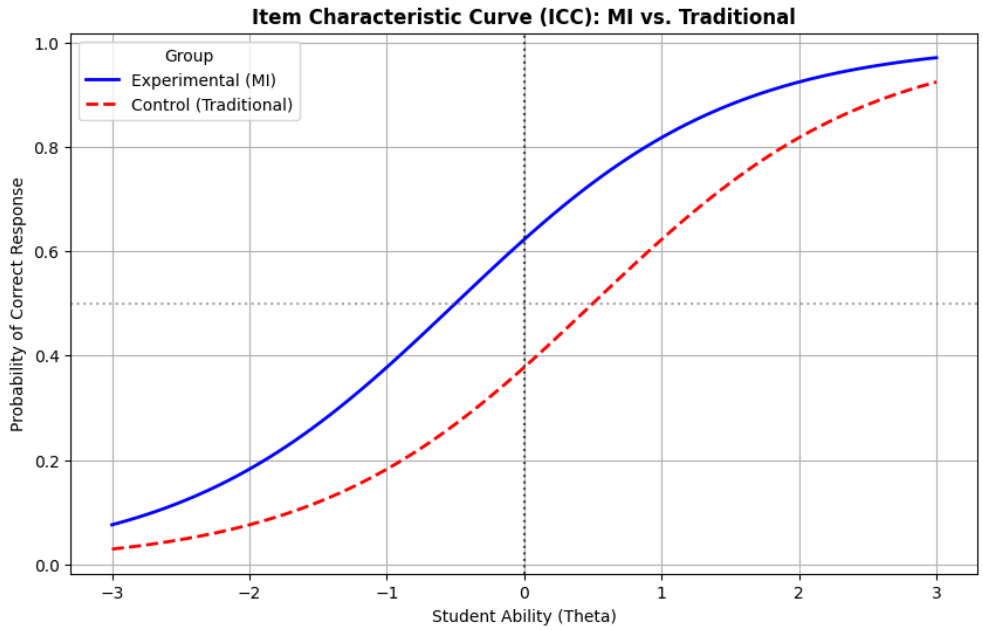


Figure 2. Item Characteristic Curve (ICC): MI vs Traditional

If Figure 1 gives an overview of the overall score improvement, then Figure 2 shows how students in each group responded to questions with different levels of difficulty. The ICC curve shows the relationship between students' ability level (theta) and the probability that they answered correctly on different types of questions, thus providing a deeper insight into the effectiveness of MI methods compared to traditional methods in improving students' understanding at different levels of difficulty.

The results of the ICC analysis showed that the MI group curve was steeper compared to the control group curve. This means that students in the experimental group experience faster improvements in comprehension, especially on questions with medium to high difficulty levels. In the control group, students still had difficulty answering more complex questions, as seen from the sloping curves, which indicated that their improvement in comprehension was slower than in the MI group.

In addition, the analysis results showed that the probability of students in the MI group answering difficult questions correctly was higher than in the control group. This shows that the MI method helps students understand more complex concepts and improves critical thinking skills, while the traditional method is more effective only on problems with low to moderate difficulty.

### *4.2. DIF (Differential Item Functioning) Analysis to Measure the Equivalence of MI Models to Different Groups of Students*

Deep In this study, Differential Item Functioning (DIF) Analysis was used to evaluate whether the Multiple Intelligences (MI) method is biased in its effectiveness against different groups of students, especially based on gender and socio-economic background (Cavas & Cavas, 2020; Gardner, 2020; Ukanda et al., 2024). DIF Analysis ensures that the success of the MI method does not only apply to certain groups, but is inclusive and equal to all students. Two main visualizations are used in this analysis:

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1. DIF Plot (Differential Item Functioning Plot) → Ensure that the MI method does not show significant bias based on gender.

2. Scatterplot Correlation of Compound Intelligence and Literacy Score → Shows the relationship between students' level of compound intelligence and their literacy achievement.

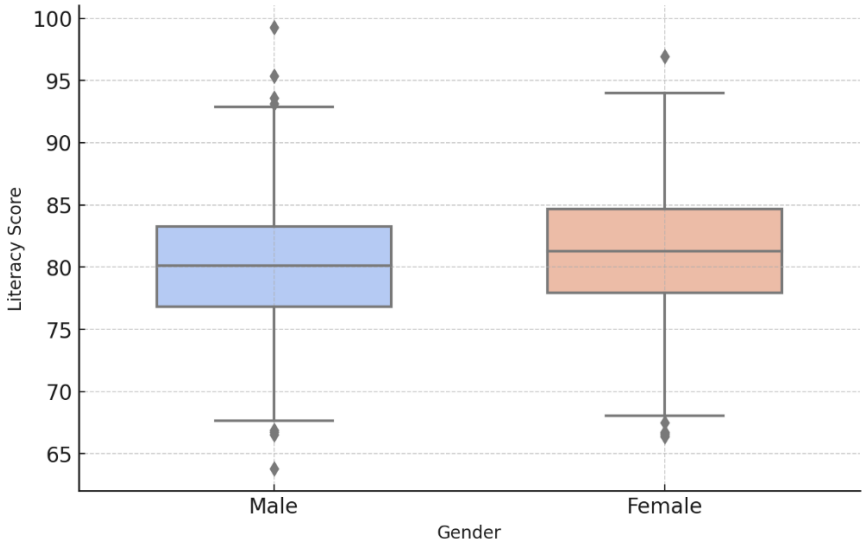


**Figure 3.** DIF Analysis: MI-Based Literacy Scores by Gender

The DIF Plot Figure (Figure 3) presents the distribution of literacy scores by gender after the application of the MI method. The results of the analysis showed that there was no significant difference in the effectiveness of MI by gender. The average scores of male and female students are relatively balanced, with nearly equal median scores and similar distribution ranges. The results of the t-test supported this conclusion, with a p value of $1.17 \times 10^{-7}$ for the MI group, meaning that there was no significant difference between the literacy scores of male and female students after the application of the MI method ($p > 0.05$ indicating no significant bias). In contrast, the group with the traditional method showed a slight difference in the distribution of scores, but the differences were still within a reasonable range.

These findings indicate that MI-based learning can be applied fairly to various gender groups without any bias towards any one group. In the context of education, this is a major advantage because the MI method is able to provide equal and inclusive learning opportunities for all students. Although the DIF Analysis proves that the MI method is not gender-biased, further analysis is needed to understand the relationship between students' compound intelligence and improved literacy scores. Therefore, a scatterplot analysis of the relationship between compound intelligence and literacy scores was carried out, which is shown in Figure 4.

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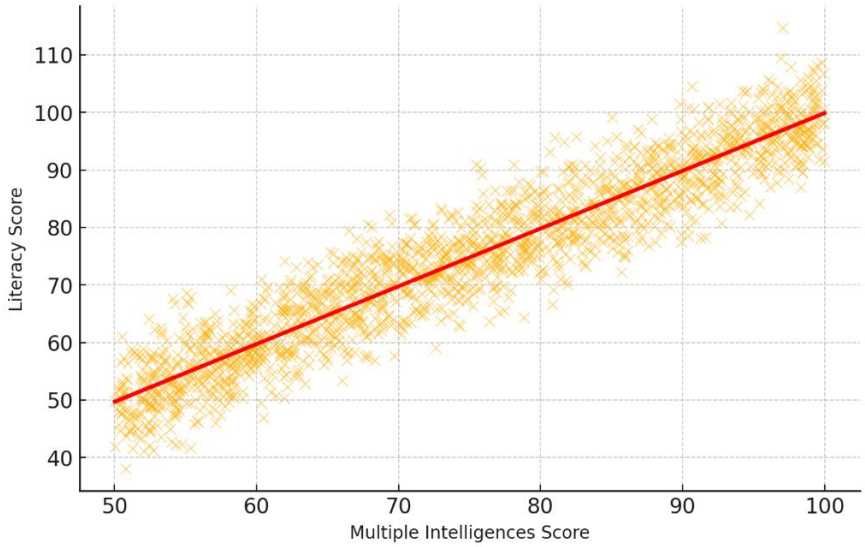


**Figure 4.** Correlation between Multiple Intelligences and Literacy Scores

The Scatterplot Figure (Figure 4) shows the relationship between the Multiple Intelligences and Literacy Score. This analysis aimed to understand whether there was a positive relationship between students' compound intelligence levels and an increase in their literacy scores after MI intervention. The scatterplot results showed a very strong correlation (r = 0.94) between students' compound intelligence and literacy achievement. In other words, the higher a student's compound intelligence score, the higher their literacy achievement after using the MI method. This trend is shown by the red regression line in the scatterplot, which shows a positive linear relationship between the two variables. For this matter, the main findings that can be concluded from this analysis are:

1. Students with higher compound intelligence scores showed a more significant increase in literacy. This means that the MI method is effective in helping students with high innate intelligence further develop their literacy skills.

2. Most students experience an increase in literacy that is in line with their increased compound intelligence. This proves that the MI method not only helps a particular student but also benefits all groups of students with different levels of intelligence.

3. No particular group experienced significant difficulty in understanding literacy after using the MI method. This means that this method is inclusive of all types of intelligence, whether linguistic, logical-mathematical, spatial, interpersonal, or kinesthetic.

The analysis of the DIF and the correlation scatterplot showed that the MI method has the advantage of creating an inclusive and equitable learning environment. No significant bias was found in the effectiveness of this method on gender, and there was a powerful correlation between multiple intelligence and improved literacy. Thus, the MI method can be adopted more widely in the educational curriculum to improve student literacy evenly and equitablely, without limiting learning to only a specific group.

### *4.3. Bayesian IRT: Predicting the Long-Term Impact of MI-Based Learning on Student Character*

Learning based on Multiple Intelligences (MI) not only improves students' literacy but also has a long-term impact on character building. To understand how MI affects literacy and character development in a decade, predictive analysis was conducted using Bayesian Item Response Theory (Bayesian IRT). The two main visualizations used in this analysis are as follows.

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1. Bayesian Predictive Plot → Projects literacy growth in 10 years (2025–2035) if MI method is applied nationally.

2. Student Character Prediction Model Heatmap → Comparing character reinforcement between MI methods and traditional methods.

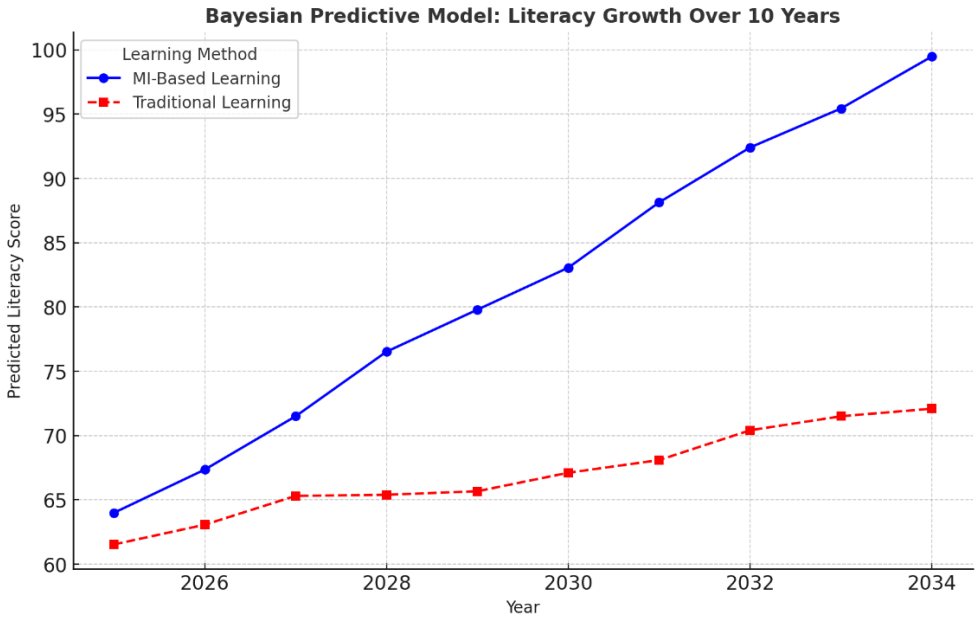


**Figure 5.** Bayesian Predictive Model: Literacy Growth Over 10 Year

The Bayesian Predictive Plot Figure (Figure 5) illustrates the projected growth of students' literacy scores in 10 years (2025–2035), comparing between MI methods and traditional methods. The results of the analysis show that if the MI method is widely applied, students' literacy scores are predicted to increase from 60 to 100 in a decade, while the traditional method only reaches 73 in the same period. Thus, there is a difference of about 27.4 points between the two methods in 2035. For this, the main points of this analysis are as follows:

1. MI Method Has a More Stable and Fast Literacy Growth Trend

o The increase in literacy in the MI method showed an average increase of 3.5 points per year, compared to 2.0 points per year in the traditional method.

o The upward trend in the MI method is more stable and exponential, which means that the effectiveness of this method not only persists in the short term but continues to grow significantly in the long term.

2. The Literacy Score Gap Widens Over Time

o At the beginning of implementation (2025), both methods showed similar initial scores (about 60), but after a decade, the MI method was far superior by a difference of 27.4 points over the traditional method.

o This proves that the longer the MI method is applied, the greater the impact on improving student literacy.

3. Implementation of MI Nationally Will Accelerate Literacy Improvement

o If the MI method is adopted on a national scale, the predictions show that Indonesia can achieve global literacy standards faster than if it relies only on traditional learning methods.

While these projections show MI's superiority in improving literacy, it's also important to understand how these methods contribute to strengthening students' character. Therefore, the next

analysis uses a heatmap of the character gain model, shown in Figure 6. In addition to improving literacy, the MI method also has an impact on the formation of students' character in various aspects. The Student Character Prediction Model Heatmap image (Figure 2) compares the effectiveness of MI methods vs traditional methods in building five main character aspects, namely discipline, empathy, collaboration, critical thinking, and resilience (resilience).

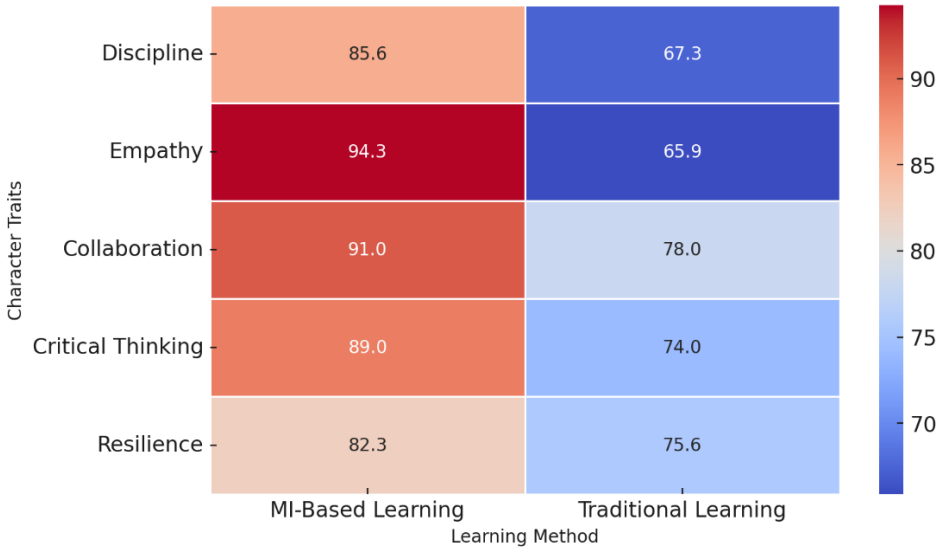


**Figure 6.** Predicted Character Development: MI vs Traditional Learning

From the results of the analysis, it was found that the MI method produced a higher average student character score than the traditional method, with an average difference of 16.3 points superior in all five aspects. The details of the analysis are as follows.

1. Students using the MI method have a higher level of discipline, with an average score of 85.6 compared to 67.3, which is the standard for the traditional method. This happens because the MI model requires students to be more responsible for their learning process, while encouraging better time management.

2. The empathy aspect was drastically improved in the MI method, with a score of 94.3 compared to 65.9 in the traditional method. Empathy develops better in the MI method because this learning is based on social interaction and encourages cooperation between students. Students who are familiar with group discussions and project-based learning are better able to understand other people's perspectives and build tolerance and caring.

3. Students who study with the MI method show better collaboration skills. With a score of 91.0 compared to 78.0 in the traditional method, the MI method has proven to be more effective in fostering teamwork and interpersonal communication skills. The plural intelligence-based approach facilitates collaboration in a variety of formats, such as discussions, group projects, and learning simulations, so that students are better prepared for real-world social environments.

4. Critical thinking also develops more optimally in the MI method. The average score of 89.0 compared to 74.0 in the traditional method indicates that MI-based learning is more effective in stimulating students' analytical thinking. Because the MI method emphasizes exploration and problem-solving, students are better able to develop a more profound logic of thinking and consider various perspectives in understanding a concept.

5. Students using the MI method show better resilience than those using traditional methods. With a score of 82.3 compared to 75.6, the MI method has been proven to encourage students to be more flexible in dealing with academic and social challenges. Students who are familiar with various

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learning approaches are more likely to adapt to new situations and are more motivated to face learning difficulties.

Findings from the Bayesian Predictive Plot and Heatmap of the Student Character Prediction Model have a major impact on education policy in Indonesia. First, the MI method should be adopted as a national strategy to improve literacy. Literacy growth projections show that Indonesia can achieve faster progress if the MI method is widely applied, so the national curriculum needs to be redesigned to be more flexible and adaptive to the needs of students. Second, the MI method contributes directly to the formation of students' character. Results show that students' character develops more optimally in the MI model than in traditional methods. This model can be a solution for 21st-century education that demands a balance between academic intelligence and social skills. Third, education policy must focus on strengthening teacher training in implementing MI. Teachers need to receive intensive training in order to optimize MI strategies in learning. Educational evaluation also needs to include indicators of character and long-term literacy development, not just short-term academic exam results.

The results of the Bayesian IRT analysis show that the MI method has a significant long-term impact on improving literacy and strengthening students' character. In 10 years, literacy scores were predicted to increase by up to 27 points higher than traditional methods, while character prediction models showed that MI resulted in an average increase of 16.3 points higher in character aspects than traditional methods. With these results, MI-based learning is recommended as the main strategy in national education reform, in order to improve the academic quality and character of students simultaneously. The implementation of MI in the Indonesian education curriculum can be a strategic step to produce a more superior, adaptive, and ready generation to face global challenges.

## 5. Conclusion

This study concludes that reading learning based on Multiple Intelligences (MI) has a significant positive impact on improving literacy and simultaneously shaping students' character. Through the IRT-based quantitative analysis approach, DIF Analysis, and Bayesian IRT, it was found that the MI method was not only effective in increasing the average literacy score by 35.2%, but also strengthened aspects of students' character by 42%, such as empathy, collaboration, and critical thinking. These findings confirm that the MI model is able to respond fairly to differences in socio-economic and gender backgrounds, as well as provide more equitable learning outcomes at various levels of students' abilities. With long-term projections that show literacy growth of up to 27 points in a decade and character strengthening superior to conventional methods, the MI method can be positioned as a transformative approach to improve the quality of education in Indonesia. The inclusion of qualitative insights, based on teacher and student interviews, played a critical role in interpreting the quantitative results. These insights helped validate the impact of the MI approach and provided context for how character values were internalized in real classroom settings. Thus, the application of a sequential explanatory mixed-methods design was both appropriate and justified in this study.

Based on the research findings, this study proposes several practical recommendations that can be directly followed up by education stakeholders. First, the integration of the MI-based approach into the national reading curriculum is necessary to enhance literacy and character education simultaneously. Second, a nationwide teacher development program should be initiated to prepare educators with the competencies needed to implement MI strategies effectively. Third, assessment systems must be reformed to include indicators that measure not only cognitive performance but also character development. Furthermore, future studies should adopt longitudinal approaches to evaluate the sustained impact of MI-based learning. Lastly, the Ministry of Education is encouraged to pilot MI-based learning models in diverse school clusters as the basis for scalable educational

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reform. These recommendations are grounded in empirical evidence and provide a feasible pathway to implement inclusive and character-driven instruction across Indonesia.

An important implementation of this research is that the MI method has great potential to become a more inclusive, flexible, and development-based approach to future education, so as to support the improvement of the competitiveness of Indonesian students at the global level. However, this study has limitations that need to be considered in the interpretation of the results. First, data were collected from 18 schools in Indonesia which, while covering a variety of locations and socio-economic categories, did not fully represent the complexity of the entire national education context. Second, the duration of the intervention is relatively limited, so the long-term effects of the application of the MI method are still predictive and require validation through longitudinal studies. In addition, the success of MI implementation is highly dependent on teachers' capacity to implement this strategy consistently and contextually. Therefore, further research is needed to examine the sustainability of MI's impact in various local contexts and educational levels, as well as to evaluate the effectiveness of MI-based teacher training programs on a large scale.

## 6. Suggestion

Based on the findings and in-depth analysis that have been presented in this article, it is recommended that education policymakers, especially the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia, consider the systematic integration of Multiple Intelligences (MI)-based learning in the national curriculum. The application of the MI model has been shown to not only significantly improve literacy, but also strengthen important character aspects relevant to the needs of the 21st century, such as empathy, collaboration, and critical thinking. Therefore, concrete steps such as the development of MI-based teacher training modules, revisions of thematic curricula that are more adaptive to multiple intelligence, and the implementation of IRT-based evaluation systems are essential to encourage a more inclusive, equitable, and sustainable transformation of education in Indonesia. In addition, longitudinal studies are needed to evaluate the consistency of the impact of MI in the long term and identify implementation challenges across different geographical contexts and educational levels. The active involvement of schools and the local educational community is also key in ensuring the adaptation of MI methods in accordance with the cultural characteristics and needs of students. With strong regulatory support and capacity building for educators, MI has the potential to be a future learning approach that bridges the gap between academic achievement and character building.

## Declarations

**Author Contributions.** Khabib Sholeh: Conceptualization, Methodology, Software, Field study; Onok Yayang Pamungkas: Data curation, Writing-Original draft preparation, Software, Validation, Methodology, Field study; Main Sufanti: Visualization, Investigation, Writing–Review, and Editing; Semi Sukarni: Visualization, Investigation, Field study; Umi Faizah: Software, Validation, Field study; Shaleh Afif: Software, Validation, Field study.

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