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Exploration of Multiple Intelligences of High School Students in Physics Subjects as A Basis for Developing Learning Methods

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ABSTRACT
Objective: This study aims to describe the profile of multiple intelligences among high school students in physics learning. The goal is to provide a basis for designing more adaptive and personalized instructional strategies that align with students' cognitive strengths. **Method:** A quantitative descriptive method with a survey approach was employed, involving 101 students from three different classes. Data were collected using a Likert-scale-based multiple intelligences questionnaire encompassing eight intelligence domains: verbal-linguistic, logical-mathematical, visual-spatial, kinesthetic, musical, interpersonal, intrapersonal, and naturalist. The data were analyzed using descriptive statistics, exploratory factor analysis (EFA), and reliability testing. **Results**: The findings revealed that intrapersonal (78.320%), interpersonal (77.030%), kinesthetic (76.780%), and naturalist (76.440%) intelligence were the most dominant among students. Verbal-linguistic (70.050%), musical (71.830%), visual-spatial (69.110%), and logical-mathematical (64.500%) also showed notable representation. EFA identified ten principal components that explained 65.040% of the total Variance. Reliability analysis showed that most factors had adequate Cronbach's Alpha values (> 0.700), although some required refinement. **Novelty:** This study provides updated empirical insights into high school students' multiple intelligences in physics learning, with a focus on the emerging dominance of kinesthetic, intrapersonal, and naturalist intelligence. It also incorporates recent psychometric validation using EFA, underscoring the need for intelligence-based instructional design. The novelty lies in combining psychological profiling with physics-specific pedagogy in a Merdeka Belajar framework.

INTRODUCTION

Indonesian education, which gave rise to the Merdeka Belajar Curriculum, is characterized by an emphasis on a more relevant, flexible, and student-centered education system. For decades, our education system has tended to focus on a uniform approach, emphasizing the memorization and quantitative mastery of material (Fitri, 2019). This often ignores the potential and interests of individual students. The Merdeka Belajar Curriculum is presented as a response to these challenges, with a vision to create a more inclusive education system that allows each student to develop according to their potential and talents. This curriculum also aims to equip students with 21st-century skills that are relevant to the changing world of work, such as critical, creative, collaborative, and communication thinking skills (Prahani et al., 2022; Iham et al., 2025;

Prahani et al., 2025). The Merdeka Belajar Curriculum emphasizes student-centered learning (Putra et al., 2020). This means that learning must be designed in a way that accommodates the various learning styles and interests of students. The concept of multiple intelligences provides a valuable framework for realizing this. The Merdeka Belajar Curriculum and the concept of multiple intelligences complement each other in creating.

More effective and meaningful learning (Sukarso et al., 2019). By understanding and accommodating the diversity of student intelligence, teachers can help each student reach their full potential (Sukarso et al., 2019). Implementing a multiple intelligences approach in learning offers significant benefits for both students and teachers (Kumar et al., 2022; Laksmi et al., 2021; Thambu et al., 2021). By understanding that each individual has a unique way of learning, teachers can create a more inclusive and effective learning environment (Rasmitadila et al., 2021; Roldán et al., 2021; Woodcock et al., 2022). This approach not only increases students' motivation to learn but also helps them understand concepts more deeply. In addition, multiple intelligences also encourage the development of various important 21st-century skills, such as creativity, collaboration, and problem-solving (Adeoye & Jimoh, 2023; Husain, 2023). Thus, students are not only ready to face academic challenges but also ready to face the increasingly complex world of work. Research by Petruta (2013) has shown increasing interest in linking the theory of multiple intelligences with physics learning practices. Previous studies have successfully identified correlations between various types of intelligence and students' learning preferences in physics subjects.

On the other hand, there are still many aspects that need to be explored further, such as the influence of multiple intelligences on long-term learning achievement, the effectiveness of various learning strategies tailored to students' intelligence profiles, and the application of multiple intelligences theory in the context of digital learning. Research on the application of multiple intelligences theory in physics learning is very relevant in the current educational context. Several recent studies reaffirm the importance of tailoring instruction to students' intelligence profiles. Walela (2024) emphasized the importance of contextualizing Howard Gardner's theory within the Indonesian educational landscape to foster inclusive learning environments. Additionally, Ni et al. (2024) demonstrated the effectiveness of multiple intelligences-based strategies in enhancing learning motivation through differentiated instruction. In science education contexts, Oladele et al. (2024) found visual and kinesthetic intelligence to be most prevalent among pre-service biology teachers, indicating the need for multimodal approaches in STEM education. These findings support the need for further exploration of the role of MI-based frameworks in subject-specific domains, such as physics. By understanding that each student has a unique way of learning, this study can make a significant contribution to improving the quality of physics learning.

This article provides practical and evidence-based solutions for researchers and educators to design more engaging and effective physics learning experiences. By emphasizing students' diverse cognitive strengths through the lens of multiple intelligences, this study introduces a more inclusive and adaptive approach to instruction. Furthermore, it contributes to the growing discourse on personalized learning by presenting empirical data that can inform both policy and practice. The novelty of this study lies in its integration of psychometrically validated intelligence profiling with physics education. This area remains underexplored, particularly within the context of the Merdeka Belajar Curriculum in Indonesia. As an exploratory effort, this research serves as a foundational step toward developing a comprehensive learning model that tailors physics instruction to students' dominant intelligences. The insights gained from this profiling not only support the formulation of future research hypotheses but also provide a strategic framework for designing differentiated learning programs tailored to students' unique potential.

This article aims to describe the profiles of multiple intelligences in high school students studying physics. By understanding the profile of each student's intelligence, it is hoped that learning can be designed to better align with the characteristics of each individual. Specifically, this study addresses the following research question: “What are the dominant profiles of multiple intelligences among high school students in physics learning, and how can these profiles inform the development of adaptive instructional strategies?”

RESEARCH METHOD

This study uses a quantitative descriptive method with a survey approach. The subjects of the study were high school students taking physics. The research sample consisted of 101 students from three different classes. Data collection was carried out through a questionnaire containing statements related to eight multiple intelligences (linguistic, logical-mathematical, spatial, kinesthetic-bodily, musical, interpersonal, intrapersonal, and naturalist). Each intelligence consists of 5 statements, using a 5-point Likert scale (ranging from "strongly disagree" to "agree strongly"). The data obtained were then analyzed using descriptive statistics to determine the average score of each intelligence. Additionally, exploratory factor analysis (EFA) was conducted to assess the validity and reliability of the research instrument (Eggen et al., 2012; Deporter et al., 2006). EFA analysis will help identify latent factors underlying students' multiple intelligences. The results of this analysis will serve as a basis for developing learning methods that align more closely with the profiles of students' multiple intelligences.

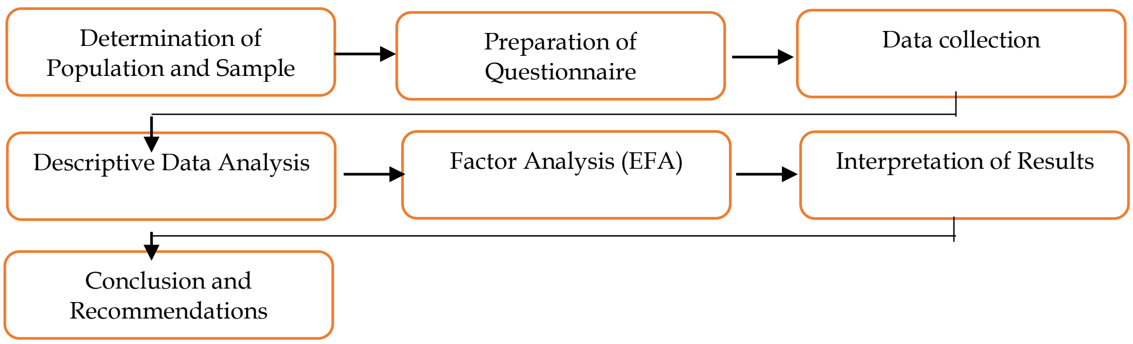

Figure 1. Research procedure flowchart in this study.

To reveal the profile of multiple intelligences in students in more detail, an instrument was used in the form of a questionnaire consisting of several statements representing the eight types of intelligence outlined in Howard Gardner's theory. Each statement is designed to describe students' tendencies in various activities or learning preferences related to each type of intelligence. Details of the statements and item codes for each type of intelligence are presented in Table 1.

Table 1. Student response questionnaire statements.

Intelligence	Statements	Code
Verbal-Linguistic Intelligence	I enjoy reading books, articles, or other writings.	a1
	I like writing stories, essays, or journals.	a2
	I easily understand lessons delivered in oral or written form.	a3
	I enjoy playing word puzzles, such as crosswords or other word games.	a4
	I am good at speaking and explaining ideas to others.	a5
Logical-Mathematical Intelligence	I enjoy playing games that require logic, such as chess or number puzzles.	b1
	I enjoy solving math problems or arithmetic problems.	b2
	I often think systematically and structured.	b3
	I easily understand patterns or relationships between numbers and concepts.	b4
	I enjoy analyzing and solving logical problems in everyday life.	b5
Visual-Spatial Intelligence	I enjoy drawing, painting, or sketching.	c1
	I easily understand maps, diagrams, and other visual instructions.	c2
	I can envision things in my mind.	c3
	I am interested in photography, design, or architecture.	c4
	I am good at planning or visualizing something before doing it.	c5
Kinesthetic Intelligence	I enjoy moving, exercising, or being physically active.	d1
	I like to learn through hands-on practice or field activities.	d2
	I easily remember things when I do them directly.	d3
	I am interested in dance, drama, and handicrafts.	d4
	I feel more comfortable learning while doing something or moving.	d5
Musical Intelligence	I enjoy listening to music in various situations.	e1
	I can easily remember the melody, lyrics, or rhythm of a song.	e2
	I can play a musical instrument or am interested in learning one.	e3
	I can easily recognize the difference in tone and voice.	e4
	I enjoy learning something with the help of a specific song or rhythm.	e5
Interpersonal Intelligence	I am easy to get along with and communicate with other people.	f1
	I enjoy working in groups or teams.	f2
	I am good at understanding other people's feelings and views.	f3
	I am often asked by friends to help solve their problems.	f4
	I feel comfortable when interacting with many people.	f5
Intrapersonal Intelligence	I enjoy reflecting on and understanding my feelings and thoughts.	g1
	I know my strengths and weaknesses.	g2
	I prefer to work or study independently.	g3
	I have a clear personal goal in life.	g4
	I frequently evaluate myself and seek ways to improve.	g5
Naturalist Intelligence	I enjoy being outdoors, such as in parks or forests.	h1
	I am interested in studying plants, animals, and the environment.	h2
	I care about environmental issues and nature conservation.	h3
	I am skilled at identifying various types of plants, animals, and natural phenomena.	h4
	I enjoy activities such as gardening, hiking, and observing nature.	h5

Table 1 is a questionnaire of student responses to measure multiple intelligences. This questionnaire consists of several statements related to eight types of intelligence, namely verbal-linguistic, logical-mathematical, visual-spatial, kinesthetic, musical, interpersonal, intrapersonal, and naturalist. Each student is asked to provide an assessment of each statement using a particular scale. The first column in Table 1 shows the type of intelligence being measured. The second column contains statements that represent each intelligence. The third column contains the code for each statement, which is used to facilitate identification during data analysis.

Three data analysis techniques are used, namely the Likert scale, average, and factor analysis (EFA). Each aspect of intelligence has a statement in the questionnaire using a 5-point Likert scale to measure the level of student agreement with the statement. The average score for each intelligence will be calculated to determine the dominant intelligence in students. EFA is used to identify latent factors that underlie students' multiple intelligences. This analysis is also used to test the validity and reliability of the research instrument. EFA will show the extent to which the items in the questionnaire measure the same construct (multiple intelligences). The reliability coefficient (e.g., Cronbach's alpha) will be calculated to measure the internal consistency of the instrument (Komang, 2021).

The results of the analysis will be interpreted to determine the overall profile of students' multiple intelligences. The intelligence most dominant in students is considered when developing learning methods. Additionally, the results of the EFA will provide information on the structure of multiple intelligence factors within the research sample. By employing this research method, it is hoped that accurate and reliable data can be obtained regarding the profiles of multiple intelligences in students, which can serve as a basis for developing more effective learning methods that align with students' characteristics.

RESULTS AND DISCUSSION

Results

This article reports on a study that aims to explore the potential of multiple intelligences in high school students in the context of physics learning. This study has significant implications in efforts to improve the effectiveness of physics learning by adjusting learning methods to the diverse intelligence profiles of students. Through a specially designed questionnaire instrument, researchers collected data from 101 students across three classes in a high school in Lamongan. This questionnaire consists of 8 aspects of intelligence, each containing five statements using a Likert scale. Thus, researchers can measure the level of student mastery of each aspect of multiple intelligence, ranging from linguistic to logical-mathematical, spatial, interpersonal, and intrapersonal intelligence.

The results of the data analysis from the questionnaire are expected to provide a comprehensive picture of the multiple intelligence profiles of high school students in the context of physics learning. This information is highly valuable for researchers to design more diverse learning strategies tailored to the characteristics of students. Research shows that most students possess high visual-spatial intelligence, allowing researchers to utilize more visual media, such as pictures, diagrams, or simulations, in delivering lesson materials.

Additionally, this research can contribute to the development of a physics curriculum that is more relevant to the needs and interests of students. By understanding the intelligence profile of students, the curriculum can be designed to accommodate various learning styles and provide opportunities for each student to develop their potential optimally (Gardner, 2003; Fleetham, 2006). Overall, this research represents an important step toward achieving more effective and enjoyable physics learning. Exploring the potential of students' multiple intelligences is expected to increase learning motivation, academic achievement, and a deeper understanding of physics concepts in students (Anwar, 2015).

Table 2. Recapitulation of response results per statement code.

Statement Code	Total	Percentage (%)
a1	296	73.267
a2	265	65.594
a3	282	69.801
a4	293	72.524
a5	279	69.059
b1	242	59.900
b2	245	60.643
b3	279	69.059
b4	246	60.891
b5	291	72.029
c1	283	70.049
c2	251	62.128
c3	319	78.960
c4	268	66.336
c5	275	68.069
d1	302	74.752
d2	329	81.435
d3	334	82.673
d4	271	67.079
d5	315	77.970
e1	338	83.663
e2	318	78.712
e3	260	64.356
e4	257	63.613
e5	278	68.811
f1	309	76.485
f2	313	77.475
f3	326	80.693
f4	306	75.742
f5	302	74.752
g1	334	82.673
g2	311	76.980
g3	287	71.038
g4	315	77.970
g5	335	82.920
h1	330	81.683
h2	308	76.237
h3	305	75.495
h4	274	67.821
h5	327	80.940

Table 2 presents a recapitulation of the total student responses for each statement, along with the percentage of answers. This percentage value shows the proportion of students who agree with the statement. The higher the percentage, the more students have the intelligence tendencies represented by the statement. By examining Table 2, we can gain a general understanding of the student's intelligence profile. The percentage of students answering statements on visual-spatial intelligence is very high, indicating that most students have strong visual-spatial tendencies. This information is beneficial for researchers and teachers to design learning activities that align with students' learning styles.

In addition, Table 2 is used to compare the level of student mastery of various types of intelligence. By comparing the percentage of answers between intelligence types, we can identify which intelligence type is the most dominant and which one needs further development. Overall, Table 2 provides valuable information about the student's intelligence profile. This information can serve as a basis for developing more effective and student-centered learning programs, thereby increasing student motivation and academic achievement.

Table 3. Recapitulation of multiple intelligences.

Intelligence	Percentage (%)
Verbal-Linguistic Intelligence	70.049
Logical-Mathematical Intelligence	64.504
Visual-Spatial Intelligence	69.108
Kinesthetic Intelligence	76.782
Musical Intelligence	71.831
Interpersonal Intelligence	77.029
Intrapersonal Intelligence	78.316
Naturalist Intelligence	76.435

To clarify the data distribution and visualize the findings more effectively, the following figure illustrates the percentage of each type of intelligence based on the results of the student questionnaire analysis.

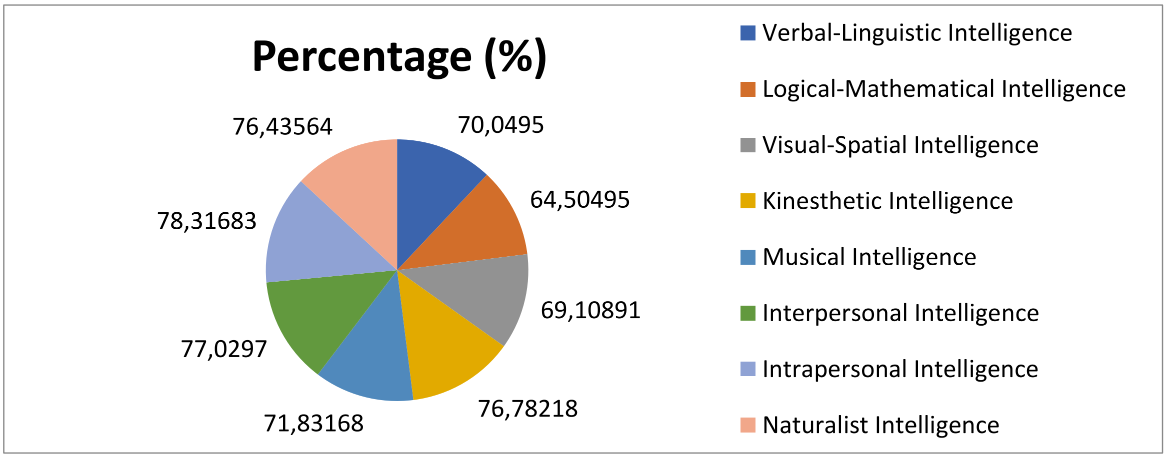

Figure 2. Percentage distribution of student intelligences.

The Multiple Intelligence Recapitulation Table 3 presents the average percentage of students who tend towards each type of intelligence. Each row in Table 3 represents one type of intelligence. At the same time, the percentage column shows the proportion of students who exhibit that tendency based on the results of the completed questionnaire. The percentage figures in Table 3 can be interpreted as follows:

1. Verbal-Linguistic Intelligence (70.049%): Students tend to have good verbal-linguistic intelligence. This means that many students enjoy reading, writing, and communicating through language.
2. Logical-Mathematical Intelligence (64.504%): Students show a tendency to think logically, analyze data, and solve mathematical problems.
3. Visual-Spatial Intelligence (69.108%): Students have good visual-spatial tendencies. They tend to learn more easily through pictures, diagrams, or other visualizations.
4. Kinesthetic Intelligence (76.782%): Students show high kinesthetic tendencies. This means that many students prefer to learn while engaging in physical activities or through direct practice.
5. Musical intelligence (71.831%): Students have musical tendencies. They tend to enjoy music, easily remember melodies, and may have musical talent.
6. Interpersonal intelligence (77.020%): Students have good interpersonal tendencies. They tend to be sociable, understand others' feelings, and work well in groups.
7. Intrapersonal Intelligence (78.316%): Students show high intrapersonal tendencies. They tend to prefer working alone, reflect on themselves, and have good self-awareness.
8. Naturalist Intelligence (76.435%): Students have naturalist tendencies. They tend to be interested in nature and the environment and have a high level of curiosity about the surrounding natural world.

Overall, Table 3 provides an overview that students in this group tend to have pretty high kinesthetic, interpersonal, intrapersonal, and naturalist intelligence. This indicates that most students in this group prefer to learn through direct experience, social interaction, self-reflection, and exploration of the natural world. This information is highly valuable for researchers to design more effective learning experiences. By understanding the intelligence profile of students, teachers can select suitable learning methods and accommodate the diverse learning styles of their students. For example, if many students have high kinesthetic intelligence, teachers can incorporate more physical activities and direct practice into their learning.

Additionally, this data can also be used to identify students who may require additional support. Students who score low on a particular intelligence can be given enrichment or remedial programs to improve their abilities. It is essential to remember that each student is unique and possesses a distinct combination of intelligence (Anwar, 2015). To gain a deeper understanding of individual students, researchers need to conduct observations and engage in direct interactions with them.

Table 4. KMO and Bartlett's test of sampling adequacy.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.705
Bartlett's Test of Sphericity	Approx. Chi-Square	2042.594
	df	780
	Sig.	.000

The results of the EFA analysis indicate that the data obtained from the multiple intelligence questionnaire are sufficient to conduct factor analysis. The KMO value of 0.705 indicates that the proportion of Variance that general factors can explain is quite good, although not too high. The significant results of Bartlett's Test of Sphericity ($p < 0.000$) also support the conclusion that the correlation between variables is strong enough to conduct factor analysis. This suggests that there is a significant relationship between the various items in the questionnaire, allowing them to be grouped into several latent factors. Thus, the data obtained from the multiple intelligence questionnaire of high school students is representative enough to identify the latent factors underlying students' multiple intelligences. The results of the subsequent factor analysis will indicate the number of factors that emerge and how the items in the questionnaire are distributed across these factors.

The KMO value approaching 1 indicates that most of the Variance in the data can be explained by common factors. A value of 0.705 indicates that common factors can explain a relatively large proportion of variance, although some variance remains unexplained. Bartlett's Test is used to test the null hypothesis that the correlation matrix is an identity matrix. If the test results are statistically significant, then the null hypothesis is rejected, indicating a significant relationship between the variables in the data. To gain a more complete understanding of the structure of students' multiple intelligence factors, further factor analysis is needed. This analysis will produce a rotation matrix that shows the relationship between the variables and the factors formed (Sugiyono, 2015). In addition, it is also necessary to pay attention to the eigenvalues and scree plot values to determine the optimal number of factors (Sugiyono, 2018).

Based on the results of the initial EFA analysis, the data obtained from the questionnaire on multiple intelligences of high school students can be used to identify latent factors underlying students' multiple intelligences. However, to obtain a deeper interpretation, further factor analysis is needed.

Table 5. Total variants.

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.602	24.004	24.004	9.602	24.004	24.004	3.832	9.579	9.579
2	3.296	8.241	32.245	3.296	8.241	32.245	3.483	8.707	18.287
3	2.745	6.862	39.106	2.745	6.862	39.106	3.276	8.190	26.477
4	2.115	5.286	44.393	2.115	5.286	44.393	3.028	7.570	34.047
5	1.817	4.542	48.935	1.817	4.542	48.935	2.862	7.154	41.201
6	1.745	4.363	53.297	1.745	4.363	53.297	2.181	5.454	46.655
7	1.434	3.585	56.883	1.434	3.585	56.883	2.128	5.321	51.976
8	1.353	3.383	60.266	1.353	3.383	60.266	1.920	4.801	56.777
9	1.220	3.049	63.315	1.220	3.049	63.315	1.724	4.309	61.086
10	1.100	2.750	66.065	1.100	2.750	66.065	1.581	3.952	65.038
11	1.069	2.672	68.737	1.069	2.672	68.737	1.480	3.699	68.737
..	…	…	…						
Extraction Method: Principal Component Analysis.									

The total variance analysis, as described in Table 5, presents the results of exploring students' multiple intelligence abilities using the principal component analysis method. The data shows that of the 11 principal components produced, only components with eigenvalues above one are considered significant. In the Initial Eigenvalues column, the first component has the highest eigenvalue of 9.602, explaining 24.004% of the total Variance. This component is a primary factor influencing the diversity of students' intelligence.

Next, in the Extraction Sums of Squared Loadings column, the first to eleventh components remain the same as the previous column, indicating that the initial extraction maintains the proportion of explained Variance. However, after rotation using the Varimax method to improve interpretability, there is a more even redistribution of Variance among the components. For example, the Variance explained by the first component decreases to 9.579%. However, the other components, such as the second to fourth components, show an increase in the proportion of explained Variance to 8.707%, 8.190%, and 7.570%, respectively.

Overall, the first ten components explained the accumulated Variance of 65.038%, reflecting that these dimensions can represent various aspects of students' multiple intelligences. These results indicate the complexity of students' intelligence, which is not focused on a single aspect but instead spread across various dimensions, including logical-mathematical, linguistic, spatial, and kinesthetic intelligence. These findings can serve as a basis for designing physics learning methods that are more varied and tailored to the diversity of students' intelligence, thereby enhancing the effectiveness of learning in the classroom.

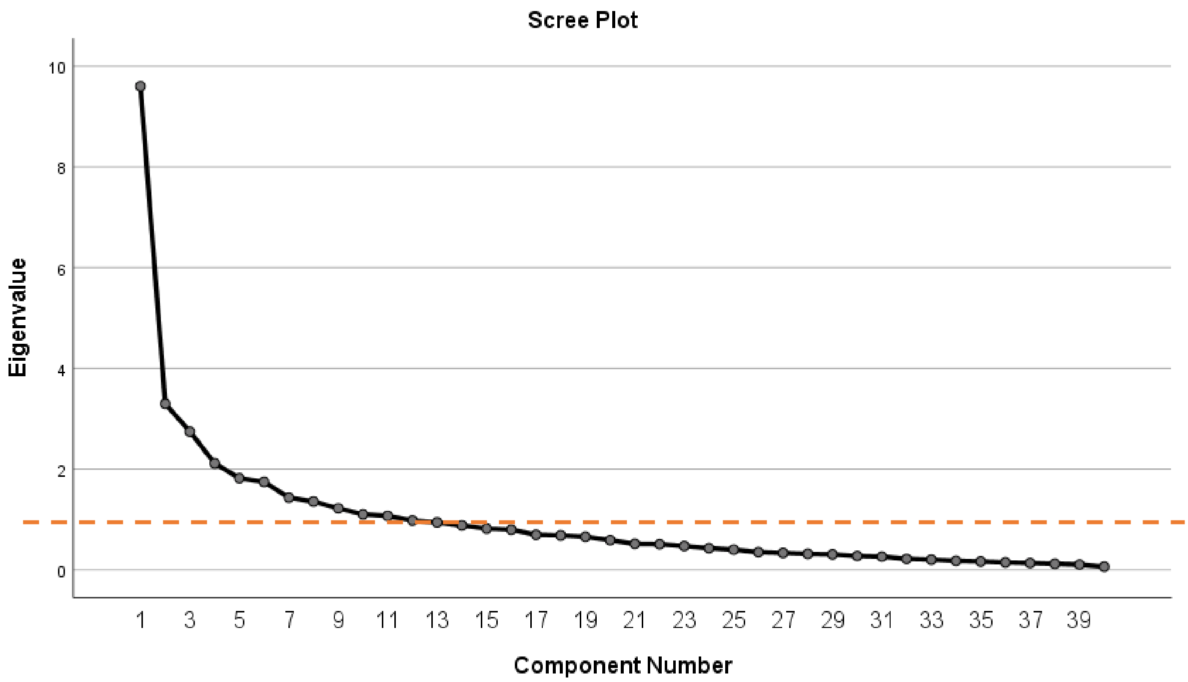

Figure 3. Screen plot.

The scree plot in Figure 3 shows the distribution of eigenvalues for each component in the principal component analysis (PCA) conducted to explore the multiple intelligences of high school students. In this plot, it can be seen that the eigenvalues decrease sharply from the first component to the second component, then slowly level off in the following components. This suggests that most of the data variance is accounted for by the first few components.

The first component has the largest eigenvalue, approaching 10, indicating a dominant contribution in explaining the total Variance. The second to fourth components show a significant decrease in eigenvalue but still make an important contribution to explaining the Variance. After the fourth component, the line begins to flatten, indicating that the contribution of Variance from the following components is decreasing and becoming insignificant.

This pattern suggests that only a few key components are essential in representing the dimensions of multiple intelligences in students. This result provides a basis for selecting a number of the most important components as data representation, which can help simplify the dimensions of multiple intelligences without losing important information. Information from this analysis can be used to design more effective physics learning methods that align with the characteristics of students' intelligence.

Table 6. Component rotation matrix.

Rotated Component Matrix											
	Component										
	1	2	3	4	5	6	7	8	9	10	11
f2	.812										
f5	.799										
d1	.708										
f1	.700										
d2	.636										
g2		.715									
g5		.674									
g4		.633									
c3		.583									
c5		.556									
g1		.497									
g3		.480								.435	
e5			.782								
e3			.754								
e4			.732								
e2			.522								
b3				.747							
b4				.733							
b2				.629							
a5				.505							
f4	.432			.436							
c2				.431			.411				
h1					.803						
h5					.740						
h2					.531		.515				
h3					.412						
c1						.724					
c4						.695					
b1						.490					
h4							.768				
a1								.726			
a2								.590			
e1			.436		.423			.452			
b5									.630		

d3				.479				.547			
d5								.484			
a3									.844		
d4										-.641	
f3		.452									.517
a4				.406							.415

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 13 iterations.

Table 6 is Rotated Component Matrix shows the results of rotation in the principal component analysis (PCA) using the Varimax method. This rotation aims to enhance the interpretability of the factors formed by grouping variables based on high correlations with specific components. In Table 6, each variable is represented by codes such as "f2", "g2", and "e5", among others, which indicate the multiple intelligences of students in specific aspects.

The first component exhibits the highest factor loadings on variables such as "f2" (0.812), "f5" (0.799), "d1" (0.708), and "f1" (0.700), indicating that this first dimension is strongly related to certain aspects of learners' intelligence. The second component shows dominant contributions from variables such as "g2" (0.715), "g5" (0.674), and "g4" (0.633), which describe different dimensions of learners' intelligence, including spatial ability and interpersonal skills.

The third component includes the variables "e5" (0.782), "e3" (0.754), and "e4" (0.732), indicating that this dimension is related to other aspects of intelligence, such as kinesthetic or intrapersonal skills. Meanwhile, the fourth component and so on describe other dimensions, with dominant variables such as "h1" (0.803) in the fourth component and "c1" (0.724) in the fifth component, which represent musical, logical, or verbal intelligence.

The results of this rotation indicate that the multiple intelligences of the students are distributed across 11 relevant components, with each component reflecting a specific group of abilities. This information is crucial in designing adaptive physics learning methods, where teachers can tailor their approach to the dominant intelligence of students. Thus, the learning process can be more effective and encourage the maximum potential of students according to their intelligence.

Table 7. Reliability of factors.

No	Factor	Cronbach's Alpha	N of Items
1	Overall reliability	.909	40
2	Reliability factor 1	.835	5
3	Reliability factor 2	.806	4
4	Reliability factor 3	.752	6
5	Reliability factor 4	.813	4
6	Reliability factor 5	.813	4
7	Reliability factor 6	.551	3
8	Reliability factor 7	.589	3
9	Reliability factor 8	.582	3
10	Reliability factor 9	.085	3

The reliability analysis in Table 7 indicates the level of internal consistency of the instrument used to measure multiple intelligences in high school students studying physics. The Cronbach's Alpha value is used as an indicator of reliability, where a value close to 1 indicates a high level of consistency.

Overall, the reliability of the instrument, comprising 40 items, is demonstrated by a Cronbach's Alpha value of 0.909, indicating that it is highly reliable in measuring students' multiple intelligences. When viewed by a factor, several factors also exhibit a high level of reliability. Factor 1 with five items has a Cronbach's Alpha of 0.835, indicating high consistency. Factors 2 (0.787), 3 (0.806), 4 (0.752), and 5 (0.813) also demonstrate adequate reliability for further analysis.

However, some factors have lower reliability. Factor 6, with three items, has a Cronbach's Alpha of 0.551, factor 8 has a Cronbach's Alpha of 0.589, and factor 9 has a Cronbach's Alpha of 0.582. Although this reliability is still acceptable in some exploratory contexts, it highlights the need for revision or further development of the items that comprise these factors.

Factors 7 and 10 do not have reliability values because each has only one item, making it impossible to calculate Cronbach's Alpha. Additionally, factor 11, with a Cronbach's Alpha of 0.085, exhibits a very low level of reliability, indicating that the items in this factor are less consistent and require improvement.

Overall, these results indicate that most of the identified factors have a good to an adequate level of reliability, but some factors need further evaluation and refinement. This is crucial to ensure that the instruments used are truly capable of representing students' multiple intelligences validly and reliably so that they can serve as a basis for developing effective learning methods in physics classes.

This response questionnaire is designed to measure the level of multiple intelligences of high school students in Physics. According to the explanation above, the questionnaire is considered valid and reliable. The data obtained from this questionnaire were analyzed to identify the dominant intelligence possessed by students. There are three highest dominant intelligences, namely kinesthetic, interpersonal, and intrapersonal. The results of this analysis will serve as the basis for developing more effective learning methods tailored to the characteristics of each student, with the expectation of increasing student motivation and learning achievement in Physics.

These findings directly address the research question by revealing students' dominant intelligence types, namely intrapersonal, interpersonal, kinesthetic, and naturalist, which offer a strong empirical basis for designing student-centered physics instruction. The discussion confirms that instructional planning should integrate collaborative learning, reflective practices, physical activities, and contextualized nature-based content to align with students' cognitive strengths.

Discussion

The findings of this study reveal a diverse and rich profile of multiple intelligences among high school students in the context of physics learning, with intrapersonal (78.320%), interpersonal (77.030%), kinesthetic (76.780%), and naturalist (76.440%) intelligence emerging as dominant. These results offer critical insights into the cognitive strengths of students, providing an empirical foundation for designing adaptive and personalized learning strategies in physics education. This aligns with Gardner's theory of multiple intelligences, which emphasizes the need to recognize and accommodate individual learners' unique intelligence profiles (Gardner, 2003). More specifically, the dominance of intrapersonal and interpersonal intelligence indicates that students are not only introspective and self-aware but also socially engaged, characteristics that must be leveraged in classroom activities through collaborative tasks, self-reflection journals, and group discussions (Alhusni et al., 2024).

The high percentage of kinesthetic intelligence aligns with previous research suggesting that students benefit significantly from experiential and hands-on learning approaches in physics (Putra et al., 2020). Physics, which often involves abstract and complex concepts, becomes more comprehensible when delivered through experimental and inquiry-based learning, especially for learners with strong bodily-kinesthetic tendencies. Furthermore, the results also confirm that many students possess high naturalist intelligence, a trait that is rarely considered in the design of physics instruction. This opens opportunities for integrating environmental contexts and real-world ecological phenomena into physics problems, aligning with Hambali's (2017) exploration of tadabbur alam (nature reflection) in enhancing naturalistic understanding. This finding is further supported by Hidayat and Hermawan (2024), who discovered that kinesthetic intelligence has a significant correlation with student motivation in physical education, highlighting the potential of active learning environments to enhance engagement. Furthermore, Walela (2024) noted that the integration of intrapersonal strategies, such as reflective journaling, helps students develop self-awareness and metacognitive skills, particularly in student-centered learning settings.

In terms of methodological implications, the use of EFA provided robust support for the construct validity of the Multiple Intelligences Instrument. A KMO value of 0.705 and significant Bartlett's test result ($p < 0.000$) confirm the appropriateness of factor analysis. The 10 extracted components explained over 65% of the Variance, which is acceptable for psychological constructs (Sugiyono, 2015). This validates that student responses indeed reflect distinct dimensions of intelligence, offering a reliable basis for instructional planning. Importantly, Cronbach's Alpha values above 0.700 for most factors confirm the instrument's internal consistency (Komang, 2022), although some dimensions (e.g., Factor 9 with $\alpha = 0.085$) require further refinement. This aligns with Muri's (2014) view that psychometric instruments in education need continuous iterative testing to improve reliability and contextual suitability.

The implications of this research are far-reaching. As proposed by Fleetham (2006), identifying intelligence profiles can transform instruction from rigid and uniform to differentiated and engaging. With over 75.000% of students displaying high interpersonal and intrapersonal strengths, methods such as peer teaching, project-based learning, reflective tasks, and personal goal-setting can be integrated into physics education. This not only enhances engagement but also supports the development of 21st-century skills, including critical thinking, collaboration, and self-directed learning.

Moreover, when logical-mathematical intelligence was found to be the least dominant (64.500%), it further underscores the need to move away from traditional lecture-based methods that emphasize abstraction and problem-solving without context. Instead, blending these methods with visual, musical, and kinesthetic techniques can enhance inclusivity and conceptual understanding across the entire intelligence spectrum. Interestingly, musical intelligence also showed a strong presence (71.830%), echoing findings by Alnahdi (2020) that integrating music or rhythm in science education improves retention and interest. This supports the growing interdisciplinary approach in STEAM (Science, Technology, Engineering, Arts, and

Mathematics) education, which highlights the role of creativity and affective engagement in cognitive development.

The current study also complements research on inclusive education. Studies by Savolainen et al. (2017) and Pulikkan and Mazumder (2020) highlight that differentiated instruction grounded in intelligence diversity helps accommodate students with various learning needs, including those with special education requirements. Thus, this intelligence-based instructional model has the potential to be integrated with inclusive and adaptive learning frameworks. From a policy standpoint, these results reinforce the relevance of the Merdeka Belajar curriculum’s emphasis on student-centered learning (Fitri, 2019). By aligning instruction with the students' intelligence profiles, educators can fulfill the curriculum's vision of respecting individual differences and promoting holistic development.

CONCLUSION

Fundamental Finding: This study reveals that high school students exhibit diverse multiple intelligences, with a predominance in kinesthetic, interpersonal, intrapersonal, and naturalist domains. These dominant intelligence suggest that students tend to learn best through physical activity, social collaboration, personal reflection, and engagement with nature. The exploratory factor analysis identified ten principal components that reflect the multifaceted nature of intelligence among students, and the instrument used showed acceptable reliability overall. **Implication:** These findings underscore the need for adaptive and differentiated physics instruction that aligns with students' dominant learning styles and intelligences. By tailoring teaching strategies to students' strengths, educators can foster deeper engagement, improve conceptual understanding, and create a more inclusive learning environment. This intelligence-based approach can also support holistic development, empowering students to reach their full potential. **Limitation:** While the instrument demonstrated overall reliability, some factors within the multiple intelligences framework require further refinement to enhance measurement validity. Additionally, the study was limited to a specific student population in three classes, which may affect the generalizability of the findings. **Future Research:** Further research is needed to improve the psychometric properties of the multiple intelligence questionnaire and to explore how intelligence profiles vary across different subjects, educational levels, or cultural contexts. Longitudinal studies could also examine how intelligence-based learning interventions impact students’ academic achievement and personal growth over time.

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