

Gardner Intelligence in Physics Students in Maluku, Indonesia

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Abstract: In this study investigated Gardner's intelligence in physics students. The sample surveyed was 360 physics students, namely physics education study programs, physics and elementary school teacher education at several universities in Maluku. The instrument used is Gardner's 1999 intelligence with 24 questions out of 9 intelligences. The results obtained indicate that the intelligences that are superior to ethnic physics students in Maluku are Mathematical Logic, Music, Interpersonal and Naturalistic. While verbal, kinesthetic, intrapersonal, and spatial intelligence is still weak. Therefore, it is necessary to apply models, strategies, and approaches and techniques that are appropriate in increasing student intelligence. To increase Gardner science student intelligence, at least pay attention to Gardner intelligence (GI) theory in the science curriculum. These findings may help to provide some practical implications for the development of effective problem-solving, creativity, critical and communicative skills in teaching physics.

Keywords: Gardner Intelligence; Island students; Problem-solving

Introduction

Physics problems occur in daily activities because they are physical events that occur around us. The ability to solve physical problems is one of the main missions in learning physics (Gök & Sýlay, 2010; Fernandez, 2017). Each student has different abilities in solving each problem, especially physics problems (Abtokhi et al., 2021). Physics learning should be taught by presenting everyday life problems so that students are better trained in increasing students' conceptual understanding, higher order thinking skills (Kwangmuang et al., 2021), scientific reasoning and problem solving. Until now physics is still considered difficult for students (Gonen & Basaran, 2013; Argaw et al., 2017).

The problem-solving process requires a cognitive function (Kirschner & Stoyanov, 2020), reasoning, and the ability of each individual to find a way out of the problems they face. This shows that the intelligence

possessed by individuals is influential in solving the problems faced (Rahbarnia et al., 2014). The intelligence in question is Gardner Intelligence which is assisted by teachers, students and parents to understand various ways of learning and developing various kinds of intellectual strengths and life skills of students (Ghaznavi et al., 2021).

GI findings have undergone development, initially only 3 namely logic-mathematical, linguistics, and spatial. Next find the 7 intelligences. After that, based on intelligence criteria, Gardner found 8 intelligences, namely naturalist and finally Gardner gave rise to the existence of the 9th intelligence, namely existential intelligence. The nine types of intelligence are verbal or linguistic, mathematical logic, musical, kinesthetic, spatial, interpersonal, intrapersonal, naturalist, and existential (Zeteroglu & Basal, 2016), as shown in Table 1.

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Table 1. Howard Gardner's Multiple Intelligences

Multiple intelligences	Description
Verbal-linguistic intelligence	Word-smart – ability to use words effectively, and to use abstract reasoning, symbolic thinking and conceptual patterning
Logical-mathematical intelligence	Number-smart – the capacity to use numbers effectively and to reason well
Musical intelligence	Music-smart – capacities such as the recognition of and use of rhythmic and tonal patterns and sensitivity to sounds from the environment, the human voice, and musical instruments
Spatial intelligence	Picture-smart – the ability to perceive the visual-spatial world accurately and to perform transformations based on those perceptions
Bodily-kinaesthetic intelligence	Body-smart – the ability to use the body to express emotion, to play a game, and to create a new product
Intrapersonal intelligence	Self-smart – self-knowledge and the ability to act adaptively on the basis of this knowledge
Interpersonal intelligence	People-smart – the ability to work cooperatively with others in a small group, as well as the ability to communicate verbally and nonverbally with other people
Naturalistic intelligence	Nature-smart – the ability to recognise patterns in nature and classify objects; the mastery of taxonomy; sensitivity to features of the natural world, and an understanding of different species
Existential intelligence	Thinking-smart – the ability to pose (and ponder) questions about life, death, and ultimate realities like 'Who are we?' and 'What is the meaning of life?'

Adaptation: (Gardner 1983; Gouws, 2007; Stanford, 2003)

Intelligences as described in Table 1 function together in ways that are unique to each individual; for example, some people appear to function at very high levels in all or most of the nine intelligences, while others appear to have none but the most basic intelligences. Most people are highly developed in some intelligences, slightly developed in others, and relatively retarded in others (Stanford, 2003).

Early 1980s, Howard Gardner introduced GI. He defines intelligence as the capacity to solve problems that are of value in one or more ways. According to GI theory, everyone has all of the intelligences, and that everyone has a unique combination (Gardner & Moran, 2006; Ferrero et al., 2021). Intelligence is actually owned by every human being from birth or innate, although not all of the nine types of intelligence are owned by all students but will form groups of intelligence that stand out in a person. For example, a scientist tends to have an intelligence group including: logical-mathematical intelligence, spatial, and kinesthetic intelligence. Meanwhile, a psychiatrist tends to have intelligence: intrapersonal, interpersonal, existential (Kuo et al., 2010).

Intelligence as the human capacity to acquire and apply knowledge and skills. GI offers innovative ways that people can demonstrate intellectually within their capacities. Every intelligence is a potential construct that can be realized as a result of experience, culture, and motivational factors that influence a person. GI theory extends the traditional view of intelligence beyond verbal-linguistic and logical-mathematical abilities. Perhaps it would be more accurate to describe it as an educational philosophy or attitude to changing the way people think about learning (Luo & Huang, 2019).

Intelligence influences a person to solve his problems, a key in learning and academic results (Dolati & Tahriri, 2017). Each intelligence will provide different thoughts on the problem at hand. Therefore, a student who has different intelligence will also have different ways of solving problems (Grežo & Sarmány-Schuller, 2022). The more developed the intelligence of a student, the easier it is to deal with problems. Therefore the intelligence possessed by students needs to be developed (Al-Qatawneh et al., 2021). The results of GI research in several countries in the world reveal a number of things as shown in Table 2.

For educators and their implications for education, the GI theory sees children as unique individuals. Educators will see that there are various variations in learning, where each variation has consequences in terms of perspective and evaluation. Children's intelligence is also based on the main views of the theory of multiple intelligences (Armstrongs, 1993) as follows: 1) Every child has the capacity to have nine intelligences. These intelligences can be highly developed, moderately developed, and less developed. 2) All children, in general, can develop each intelligence to a sufficient degree of mastery if they receive sufficient support, enrichment and instruction. 3) Intelligence works together in daily activities. Singing children need musical and kinesthetic intelligence. 4) Children have various ways to show their intelligence in each category. Children may not be very good at jumping but are able to dance well (kinesthetic intelligence), or don't like to tell stories, but quickly understand when spoken to (linguistic intelligence).

Table 2. Gardner's Intelligence Findings in Several Countries in the World

Country	Findings	Source
Japan	Boys have higher intelligence than girls	(Furnham & Fukumoto, 2008).
Mexico	Male students in elementary school are smarter than female students	(González-Treviño et al., 2020)
Malaysia	Interpersonal and intrapersonal are the highest multiple intelligence abilities of school leaders while naturalistic, bodily-kinesthetic, and musical-rhythmic are at the lowest level.	(Piaw & Don, 2014)
Iran	Mathematical and Spatial Intelligence in Iranian English major sophomores at Islamic Azad University-Tabriz Branch.	(Seifoori & Zarei, 2011)
Turky	Almost all participants (97%) agreed to use all types of intelligence in the process of learning a foreign language and linguistic intelligence alone is not a guarantee success in learning a foreign language.	(Savas, 2012)
Saudi Arabia	Physical Intelligence- Kinesthetic Their bodies are relatively the same. However, the teaching strategies used in intrapersonal and logical-mathematical intelligence are inconsistent among students of the Department of Education and Curriculum at Imam Mohammad Ibn Saud Islamic University.	(Sulim, 2012)
Taiwan	GI can increase, 1) learning motivation, (2) learning achievements, and (3) assisting the industrial world in developing the potential of human resources effectively	(Lei et al., 2021)
Philippine	The intelligences that stand out for engineering students in the Philippines are interpersonal, mathematical, and kinesthetic intelligence. Besides that, visual, linguistic, interpersonal, and kinesthetic intelligence is also high.	(Pocaaan, 2022)
Spain	Logical-mathematical intelligence is more dominant in prospective teacher students at the University of Extremadura's Education Faculty.	(Hernández-Barco et al., 2021)
Russia	Predominant verbal, logical, and spatial intelligence	(Furnham & Shagabutdinova, 2012)

One's intelligence can be developed by learning (Maharani et al., 2020). By studying, one can gain a lot of knowledge, train the mind and improve abilities (Cowan, 2014). Unfortunately, often a student is less effective in the learning process. So that what he learned could not be accepted or understood properly. This shows the need for effective action when learning. One of the things that can help learning activities to be effective is to adapt the learning process to the tendency of the learning style (Leasa et al., 2018; Leasa et al., 2020). There are several studies on learning Physics with documented literature that have poor student performance due to learning difficulties. Problems faced by students, for example in the topic of electromagnetism which may not be the same as Quantum Physics.

The results of a study in Nigeria show that no student gets a physics score above 46%. This is a bad show (Aina, 2018). Di Inggris, Wales dan Irlandia Utara, anak laki-laki lebih tertarik untuk mengetahui topik ilmu fisika sedangkan anak perempuan lebih tertarik

pada ilmu biologi dan lingkungan (Murphy & Whitelegg, 2006). In the US, Physics is lagging behind other sciences and women are less interested than men in studying physics (Lock & Hazari, 2016). According to Wilson et al., (2016), there was a statistically significant gap in the overall Physics performance of men and women on the Australian Science Olympiad Examination (ASOE). According to Singh & Marshman, (2015), learning quantum mechanics is considered a major challenge for students. Du Plessis et al., (2014) stated that 16% and 30% of science teachers in Australia and South Africa were respectively unqualified, while 31.4% of physics teachers were unqualified in England.

The physics problems above can be overcome with the support of teachers, parents, government and students. Each student must have multiple intelligences that vary. Thus, it is necessary for teachers to know the intelligence of their students to increase effectiveness in learning (Wilson-Wünsch et al., 2016). In addition, when learning activities are in accordance with students' intelligence, the learning process will become fun

activities for students. Appropriate intelligence can enhance the effectiveness of learning (Abenti, 2020). When learning is effective, any knowledge learned can be well received, indirectly increasing the intelligence possessed by these students (Rasheed & Wahid, 2021).

Intelligence is an intellectual or habit that is liked by students and can help them understand what is learned. When students' understanding increases, this will also help students solve each problem (Pashler et al., 2009). In other words, students who study according to their learning tendencies will improve the student's ability to solve the problems they face. How to learn according to intelligence can be applied in learning in the classroom. Teachers can choose a teaching method that adapts to student learning tendencies. Unfortunately, most teachers pay little attention to the needs of students with their learning styles (Moussa, 2014).

The research objective was to map the Gardner Intelligence of physics students in the islands of Maluku in physics learning so that teachers can choose teaching methods that suit the needs of students. Thus the teacher can use a varied approach and can help students overcome difficulties in learning by adjusting student intelligence.

Method

Types of research

The type of research used in this study is the survey method. This study collected information from individual samples through answers to questions in the form of a questionnaire with items assessed numerically. Questions that are made can range from several targeted questions from individuals to obtain information related to behavior and preferences (Ponto, 2015).

Participant

The research data sources were physics students, namely physics, physics, engineering, and elementary school teacher education students who studied physics at several public and private universities in Maluku Province. The subjects studied were students aged 18-21 years. The number of male students is 160 people and female students are 200 people. The research was carried out from January to November 2022. The survey was conducted on 360 students.

Research Instruments

The research instrument developed was Adapted from Gardner 1999 Multiple intelligence questionnaires were used to determine the fundamental intelligence

possessed by students. There are 8 intelligences that will be examined by researchers, namely: linguistic-verbal intelligence, logical-mathematical intelligence, spatial intelligence, bodily-kinesthetic intelligence, musical intelligence, interpersonal intelligence, intrapersonal intelligence, naturalist intelligence, and existential intelligence which are described in 24 questions. These items and your rating on a 4 point scale. Each rating corresponds to how well the following questions describe you: 1 = completely different from me. 2 = somewhat different from myself 3 = slightly like me 4 = very similar to me.

Data analysis technique

After the survey instrument items were scored, the points for each intelligence were totaled for each student in both groups. Next, all the points filled are added up. The next step is analyzed using the Microsoft Excel software program. Excel also helps determine means, standard deviation, percentages and ratings for each multiple intelligence.

Result and Discussion

Verbal intelligence uses language effectively. Verbal intelligence has a significant role in helping students solve physics problems they face (Zainuddin et al., 2017). In line with that, teacher-guided student physics learning through representational reasoning. (Waldrip et al., 2013) states that the existence of multiple representations can be grouped explicitly, namely knowledge of pictures, tables, graphs, mathematics, and diagrams. This learning situation can improve students' mathematical logic and spatial intelligence in physics.

Physics learning must have a clear experience of students to increase the ability to construct, understand, and apply the concepts studied. In addition, learning physics continues to be assessed and developed to produce learning models that are up-to-date and contextual and understandable to stakeholders in the regions. Identification of student intelligence is rarely used as the basis for every learning design, strategy, and approach, as well as the evaluation system applied (Macnamara, 2016). This is because learning strategies contribute 20.6% to the development of students' multiple intelligences (Winarti et al., 2019). This finding is supported by educational psychology experts who found that intelligence is influenced by several factors such as genetics, nutrition, and the environment in which a person is raised (Bouchard & McGue, 2003; Arden et al., 2009; Gaundare & Yeole, 2014).

Tabel 3. Frekuensi dan Persentase Peserta Dengan Intelligensi Gardner

Gardner's Intelligence Type	Scale and Number of Respondents			
	4	3	2	1
A. VERBAL THOUGHT				
1. I am good on verbal tests, such as the verbal section on the SAT.*	49	155	125	39
2. I am good at reading and read a lot.*	105	180	60	27
3. I like the challenge of solving problems.*	106	148	83	31
B. LOGIC / MATHEMATICS THINKING				
4. I am a very logical thinker.*	63	193	87	31
5. Like to Think Like a Scientist.*	43	123	150	56
6. Mathematics Is One Of My Favorite Subjects	75	84	108	101
C. SPATIAL EXPERTISE				
7. I'm good at visualizing objects and styling from different perspectives.	66	168	101	31
8. I have the ability to map out spaces and locations in my mind.	59	123	127	69
9. If I had the desire, I think I could become an architect.*	46	86	132	103
D. BODY / KINESTHETIC SKILLS				
10. I can coordinate eye-hand very well.*	109	159	69	35
11. I excel at sports.*	88	123	103	55
12. I am good at using my body to show expression, such as dancing.	90	144	96	67
E. MUSIC EXPERTISE				
13. I can play one or more musical instruments well.*	57	95	106	112
14. I have a good "hearing" for music.*	142	115	72	36
15. I'm good at composing songs.*	29	80	122	140
F. EXPERTISE FOR UNDERSTANDING YOURSELF				
16. I know myself and view myself positively.*	186	113	40	31
17. I am comfortable with my thoughts and feelings.*	183	110	50	28
18. I have problem solving skills.*	104	165	69	34
G. EXPERTISE TO ANALYZE OTHERS				
19. I am very good at "reading" other people.*	87	145	102	38
20. I am good at working with other people.*	132	164	44	31
21. I'm a good listener.*	197	121	26	25
H. NATURALIST EXPERTISE				
22. I am good at observing patterns in nature.*	66	153	114	39
23. I excel at identifying and classifying objects in natural environments.	65	149	118	37
24. I understand natural and man-made systems.*	88	166	87	36

* Description 1: completely different from myself, 2 = somewhat different from myself, 3 = somewhat like me, 4 = very much like me

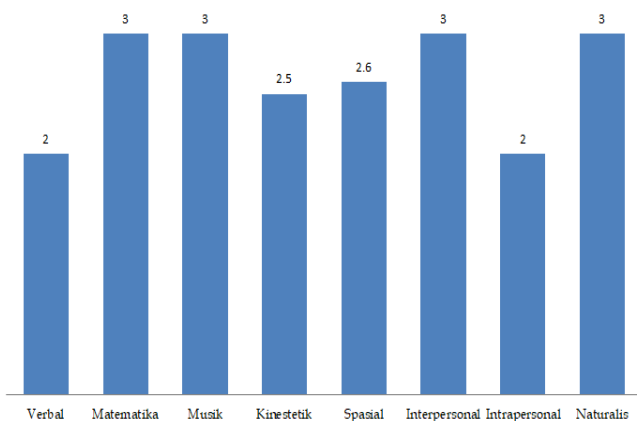


Figure 1. Gardner Intelligence for Archipelagic Physics Students in Maluku, Indonesia

Genetic factors do provide the potential for the development of one's intelligence, but other factors such as nutrition and the environment also affect the development of intelligence. According to Deary et al., (2006), an environment enriched by challenges and

stimulation affects memory connections, which means it affects the level of intelligence.

The second intelligence is mathematical logic. The subject of intelligence like this depends on how students develop this intelligence. This intelligence has the biggest role among other types of intelligence in solving physics problems. This is caused by solving physics problems that require reasoning and logic in it. Mathematics and the natural and social sciences are intimately connected; mathematics is the key and the language of science. Mathematics is used to solve problems in physics from elementary to high school and even university as well as everyday life and a tool for developing theories in physics (Doran, 2017). Mathematics as a tool for quantitative relationships in science subjects that can be modeled, calculated and predicted (Turşucu et al., 2017).

Logical-mathematical intelligence includes not only mathematical abilities but also mathematical logic abilities, scientific methods, deductive, inductive

thinking, syllogisms, and analogies. Because learning physics trains more logic skills through scientific process skills, and has little to do with mathematical calculations, the true development of intelligence is scientific logic ability rather than mathematical intelligence. As a result, the increase in mathematical logic intelligence related to scientific logic is not captured by the instrument. The decline in mathematical logic intelligence is similar to other studies conducted by other causes of this phenomenon related to learning activities. In this lesson, students are trained to formulate problems, predict, experiment and observe the results, analyze data, classify and draw conclusions. Implementation of GI-based learning will improve several types of intelligence such as interpersonal, intrapersonal, kinesthetic, and visual spatial (Hanafin, 2014).

Physics teachers naively believed that more practice in math classes contributed more to the transfer of physics. They ignore the conceptual understanding in mathematics that underlies physics problems. Physics without mathematics will become a popular science, but it must be remembered that for successful learning to teach physics it is necessary to know the basic concepts of physics. One of the mathematical topics that is the focus of physics is the study of physical laws and functions. It requires students to recognize and describe laws, and to create deep mathematical models to predict the behavior of the real effects exhibited by the observed laws. This process requires practice and experience (Zubac, 2022). This is in line with the results of research conducted in Malaysia for science students in junior high schools which showed that GI-based online learning had an effect on physics learning achievement in the concepts of force and motion in improving mathematical logic and intrapersonal intelligence (Ahamad et al., 2021).

Online-based learning can collectively build social interaction thereby encouraging new knowledge. Communication and collaboration in online assignments and quick feedback in discussions help students with intrapersonal intelligence to better understand physics learning material easily. Thus, stimulating active participation in group work also indirectly always motivates students to search for information continuously. As well as being able to maintain student knowledge in the long term or sustainable (Greenhow & Robelia, 2009).

The third and fourth intelligences in this study are spatial and kinesthetic. This intelligence also has a big enough role in helping solve physics problems. Spatial intelligence is able to visualize the actual conditions in the mind. Velázquez & Méndez, (2021) argues that spatial intelligence is very influential on results, especially on student learning outcomes. Special

intelligence can be developed in STEM or STEAM in learning physics. With STEM or STEAM can improve kinesthetic and collaborative learning, visualization, object interaction and increase motivation, satisfaction and willingness to learn for students (Zapata-Ros, 2015). The aspect of spatial intelligence is a teaching strategy that is oriented towards academic abilities and focuses on the potential of each student (Amaluddin et al., 2019).

Kinesthetic intelligence is very closely related to skills. Subjects with visual and auditory learning styles did not stand out in this intelligence. This is caused by the habits of both of their learning styles which are not actively moving. On the contrary, subjects with kinesthetic learning styles stand out in this intelligence. This is because subjects with kinesthetic learning styles are active and enjoy learning by moving and practicing. This habit hones their kinesthetic intelligence. This intelligence provides a significant role in helping students solve physics problems. The research results are in line with Şuruba-Rusen (Vasiliu) et al., (2020) who carried out a survey of 111 students in Romania where the prominent intelligence was kinesthetic because it was dominant in practicing sports in physical and sports education students, National University.

The fifth intelligence is musical. This intelligence is closely related to hearing, feeling, and its main skills in playing music. Subjects of this intelligence tend to be higher. Because musical intelligence is not related to the ability to reason and form physical concepts. The world of education today tends to emphasize cognitive aspects that lead to intellectual intelligence alone, so that human robots are born. Human resources who do not have a spirit or character who are skilled and lack ethics, thus giving birth to people who think pragmatically. Therefore, intellectual intelligence needs to be balanced with emotional intelligence which in this case is done through art education.

Music is very important in the curriculum, for several reasons: 1) Music is a valuable knowledge; 2) music presents cultural heritage; 3) the music itself is intelligent and independent expressive; 4) music allows high expression of thoughts and feelings, 5) music teaches students how to relate to other people, both in their own culture and foreign cultures; 6) music enhances learning in all other subjects; 7) music helps students know that not all life can be measured; 8) music uplifts the spirit. Musical intelligence is present in everyone from birth, because it is related to life and soul, it is most likely that musical intelligence is present in reality before birth and will be together as the essence of the soul after death (Motello, 2004).

Music has lived and grown in the culture and traditions of the Maluku people since the past, serving as a conductor or accompaniment in various ceremonies, commemorations and celebrations for the people of

Maluku until now. This is due to the existence of DNA or the nature of self-identity that has existed since birth and needs to be developed. In 2019 UNESCO designated Ambon as a World Music City based on the identity of the Ambonese who are known for their good voices. For the Moluccas Singing is something natural. Everyday language says that the Moluccans just speak melodiously, let alone sing. This is because Nature has naturally given it to the Maluku people.

The sixth intelligence is interpersonal. This intelligence is related to the ability to understand oneself and be able to recognize the talents and abilities they have. This is influenced by their study habits that pay less attention to themselves. Interpersonal intelligence does not play an important role in solving physics problems. This is because interpersonal intelligence does not help in terms of understanding concepts, as well as formulating solutions to physics problems. The results of other studies state that interpersonal intelligence can be developed through practicum activities. In the form of gathering basic knowledge by equating their own opinion with the group, this stage guides individuals to see various phenomena from other people's perspectives, to understand how they see and feel, so that they can build good skills in organizing teams, establishing cooperation or maintaining unity in practicum group (Astuti et al., 2019).

The seventh intelligence is intrapersonal. This intelligence is related to the ability to understand other people. Interpersonal intelligence relates to the concept of interaction with other people, the intended interaction is not only related to discussion, sharing joys and sorrows, but more deeply about understanding thoughts and feelings and the ability to provide empathetic responses (Muqodas et al., 2020). The essence of academic guidance is an effort in the learning process that aims to overcome difficulties in learning physics. So that students have the opportunity to hone logic and use creativity to explore their brains without limits which can improve their mathematical intelligence, sharpen logical patterns and strengthen student relationships.

The eighth intelligence in this study is naturalist. This intelligence is closely related to nature and everything in it. Subjects with a visual learning style have this intelligence with quite high criteria. This is due to the habits of subjects with a visual learning style who tend to enjoy digging up information by seeing and observing. Thus, it will affect indirectly when enjoying the beauty of nature. Subjects with an auditory learning style are quite weak in this intelligence because they will tend to use their sense of hearing rather than their sight, while to enjoy nature, the sense of sight is more dominant (Ghaznavi et al., 2021). Subjects with kinesthetic learning styles have high naturalist

intelligence. This is caused by their habit of enjoying physical activity and mingling with nature. This intelligence does not play a big enough role in solving physics problems. The results of research by Yavich & Rotnitsky, (2020) on 158 students in Israel explain that the dominant intelligence that greatly influences and measures achievement in the education system is not linguistic-verbal, but only logical-mathematical. This means that logical-mathematical is very important for students' basic intelligence in their future lives at the junior high, high school and tertiary levels and even the world of work and everyday life.

Conclusion

From the results of the findings and discussion above, it can be concluded that the intelligences that excel for Indonesian science students in Maluku are Mathematical Logic, Music, Interpersonal and Naturalistic. Meanwhile, Verbal, Kinesthetic, Intrapersonal, and Spatial intelligence is still weak. Therefore, it is necessary to apply models, strategies, and approaches and techniques that are appropriate in increasing student intelligence.

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