DEVELOPMENT OF E-MODULES BASED ON MULTIPLE INTELLIGENCES TO ENHANCE THE PROBLEM-SOLVING ABILITY OF JUNIOR HIGH SCHOOL STUDENTS (STUDENT RESPONSES)

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Abstract

Mathematical problem-solving ability is the ability of students to understand and solve mathematical problems that are given comprehensively. However, in reality this ability is still a concern and needs to be improved. One of the factors that needs to be considered in the independent curriculum is the multiple intelligence of students. So far, the multiple intelligences possessed by students have not been considered in the learning process. Students with different intelligences will have different ways of learning. To overcome this, it is necessary to design e-modules that can help students in online learning. Because intelligence is one of the factors that determine the success of the learning process, the designed e-module will also pay attention to the potential of multiple intelligences possessed by students. The purpose of this research is to produce a valid, practical, and effective compound intelligence-based e-module to improve students' mathematical problem-solving skills. This development research uses the Plomp model, which consists of three phases, namely preliminary research, development or prototyping phase, and assessment phase. The instruments used are interview guidelines, observation sheets, questionnaires, and tests of mathematical problem-solving abilities. The data obtained were analyzed in descriptive statistical and descriptive techniques. The results obtained are that valid and practical system of two-variable linear equations topic e-modules have been produced based on student responses.

Keywords: e-Modules, Multiple Intelligences, Mathematical Problem Solving.

INTRODUCTION

Proficiency in mathematical problem-solving is one of the objectives of mathematics education (Al Ayubi et al., 2018; Hidayat & Ayudia, 2019; Nurhasanah & Luritawaty, 2021; Suhandri & Sari, 2019). The potential to comprehend and work through mathematical problems in their whole is known as problem-solving skills, and it is essential to meet obstacles in the modern era of globalization and knowledge (Iswara & Sundayana, 2021; Laia & Harefa, 2021; Meika & Sujana, 2017; Zhou et al., 2019).

This ability is often considered at the heart of mathematics (Jäder et al., 2019; Olivares et al., 2020; Putra, Putri, et al., 2018; Putra, Thahiram, et al., 2018). NCTM explains five basic mathematical ability standards, namely problem solving, reasoning and proof, communication, connection, and representation (Mufidati & Kholil, 2021; Sormin & Sahara, 2019). Learning focuses more on problem-solving processes and strategies (Jäder et al., 2019).

It is demanded of students to apply the mathematical ideas they have studied during problem solving. Problem-solving ability affects cognitive abilities (Jäder et al., 2019; Rahmmatiya & Miatun, 2020), critical and creative thinking (Laia & Harefa, 2021), and student confidence (Laia & Harefa, 2021; Meika & Sujana, 2017; Prendergast et al., 2018; Putra, Putri, et al., 2018).

Mathematical problem solving ability remains not very high in actual life situations (Amam, 2017; Ansori & Herdiman, 2019; Asih & Ramdhani, 2019; Barus & Hakim, 2020; Hidayat & Sariningsih, 2018; Putra, Thahiram, et al., 2018). Such as the PISA results in 2015 where Indonesia was ranked 62nd out of 70 countries, while in 2018 Indonesia was ranked 72nd out of 79 countries with an average score of 379 (Hermaini & Nurdin, 2020; Yuhani et al., 2018).

The low ability to solve mathematical problems can also be seen from the research of Nurhasanah (2021) and Iswara (2021) which states that students have difficulty solving story problems. It is difficult for students to distinguish between what is known and what is asked in a question, and they are unable to apply prior knowledge to solve issues (Amalia et al., 2019; Fitriana et al., 2019).

Rahmmatiya (2020) and Elita (2019) revealed when students prefer to wait for the teacher's explanation rather than trying to find it. The reasons include students not being used to solving non-routine problems (Iswara & Sundayana, 2021; Jäder et al., 2019; Nurhasanah & Luritawaty, 2021; Putra, Thahiram, et al., 2018; Suhandri & Sari, 2019), teachers have not paid attention to the multiple intelligences possessed by students (Indriani & Hariastuti, 2017; Susilo et al., 2018; Suwanto, 2019), the use of learning media that is not optimal (Baharuddin et al., 2020; Hendi et al., 2020; Indah & Nuraeni, 2021; Saputri et al., 2018; Siamy et al., 2018; Yuliana et al., 2018), as well as the lack of interest and motivation in learning students (Finariyati et al., 2020; Hidayat & Ayudia, 2019; Laksmiwati & Retnowati, 2019; Ningsih et al., 2021; Nugraha et al., 2019).

Each student's aptitude needs to be taken into consideration during the learning process. One such potential is intelligence. Intelligence is a person's ability to solve a problem (Aini et al., 2018; Laksmiwati & Retnowati, 2019; Yasa et al., 2017). Intelligence is related to the ability to solve a problem (Kurniawati & Kurniasari, 2019). Gardner revealed nine types of intelligence that a person possesses, namely linguistic, mathematical logical, spatial visual, kinesthetic, musical, interpersonal, intrapersonal, naturalist, and existential intelligence (Indriani & Hariastuti, 2017; Kurniawati & Kurniasari, 2019; Nugroho & Husni, 2020; Susilo et al., 2018). Through the theory of Multiple Intelligences (MI), there are no students who cannot, because every child must have one advantage (Fathani, 2019; Nisa & Setiawan, 2018).

Learning that involves multiple intelligences provides opportunities for students to use their intelligence in demonstrating what they are learning (Palayukan & Ledon, 2019; Prajitno & Ladyawati, 2019; Sunendar, 2017; Susilo et al., 2018). The MI theory is one of the latest changes to learning.

It is more accurate to characterize a person's cognitive competency as an expression of their abilities and intellect, which is the next level thinking ability. Individuals have varying degrees of competence and possession, yet everyone possesses each of these abilities to some extent (Kirkgöz, 2010; Masoomeh & Mahdieh, 2014; Taaseh et al., 2014).

Some research results also show that learning involving multiple intelligences is effectively used in mathematics learning. Research conducted by Nugroho (2020) states that the learning achievement of students with linguistic intelligence in the TAI learning model is better than Jigsaw. Suwanto (2019) also revealed that mathematics learning outcomes with cooperative learning based on multiple intelligences are better than ordinary learning.

The results of Laksmiwati's research (2019) show that geometry learning tools based on multiple intelligences make a positive contribution to teachers and students. When creating books, Boulmaiz (2017) says that the requirements and potential of the students ought to be considered. MI theory can make a major contribution to teaching and learning topics because it allows engagement and consideration of students' needs, potential, learning style, and intelligence.

The MI theory has been adopted in the curriculum at the elementary, junior high, and even university levels (Botelho, 2003; Snider, 2001). Snider (2001) utilizes MI in school books and teaching means that students are taught and can demonstrate their understanding in a number of different ways. Boulmaiz (2017) states that the needs and potentials of students must be taken into account when designing textbooks.

MI theory can make a great contribution to teaching and learning, as it allows for the involvement of students' needs, potentials, learning styles, and intelligence. Learning will be optimal if teachers pay attention to the learning style and intelligence of students (Taufik & Adiastuty, 2017). Books have become the most used resource in the classroom and in our daily lives. Books serve as an intermediary in communicating students' learning goals with the help of teachers.

A previous study has been conducted on the inclusion of MI in school textbook (Al-Zoubi & Al-Adawi, 2019). Books like this are very helpful for students in learning. But with online learning, teaching materials in the form of softcopy are needed. Because the use of technology in learning is very necessary (Ramadhani & Fitri, 2020). By involving technology, learning can take place anywhere and anytime (Feriyanti et al., 2019).

Therefore, the modules to be designed also utilize technology, which we often know as e-modules. The e-module will be designed as attractive as possible by combining images, animation, audio, and video so that it can be a special attraction for users. Teachers can also control teaching materials according to students' ability levels (Feriyanti et al., 2019; Ramadhani & Fitri, 2020).

Furthermore, Aji (2021) revealed that the use of e-modules is effective in improving students' ability to understand the material. Therefore, in this study e-modules based on multiple intelligences were designed so that students are more motivated to learn and enjoy learning mathematics.

METHOD

This development research uses the Plomp model which consists of three phases, namely preliminary research, development or prototyping phase, and assessment phase (Plomp & Nieveen, 2013). In each phase there is a formative evaluation as shown in Figure 1.
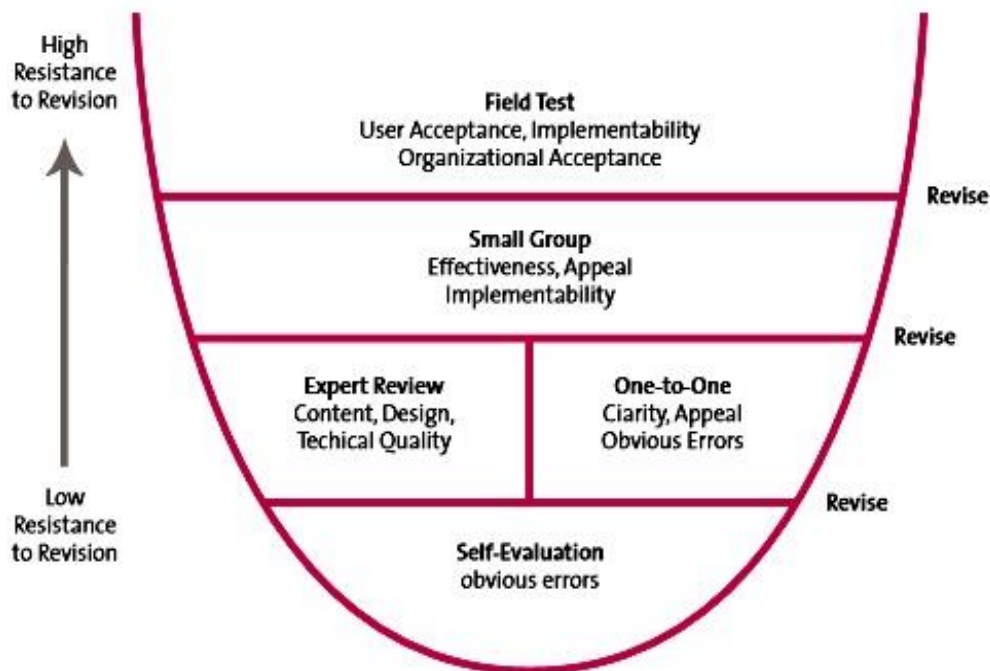
Figure 1: Layers of the Formative Evaluation of the Plomp Development Model

The details of the development procedure include the following steps:

Preliminary Research

For learning tools, in this stage, identification and study are carried out on the analysis of needs, curriculum, students, and concepts.

Development or Prototyping Phase

In this phase, the product developed is called prototype I. In prototype 1, self-evaluation and expert review are carried out to test the validity of the e-module that has been designed. The result of the improvement of e-modules based on multiple intelligences is called prototype II. After the learning tools were revised based on one-on-one evaluation inputs, a small group evaluation was carried out, prototype III e-module was tested in a small group evaluation of six students in grade VIII SMP with heterogeneous abilities (low, medium, high). The instrument used for small group evaluation data is in the form of observation sheets. After a small group evaluation, the revised e-module is called prototype IV.

Assessment Phase

At the assessment phase stage, practicality is tested, the effectiveness of the e-modules designed, whether or not it has an effect on students.

The research subjects were grade VIII students of SMPN 7 Padang. In determining test subjects at each stage of research, refer to the development procedure so that it is determined as needed. The instruments used in the development of the device are validity assessment sheets from experts for validity tests, practical test sheets from experts or mathematics teachers.

RESULTS AND DISCUSSIONS

A. Preliminary Research Results

Teachers adopt the PBL paradigm when teaching mathematics, according to evidence gathered from teacher interviews. Some expected mathematics learning objectives have been achieved and some have not been achieved. The environment and personalities of the students in every class have a major impact on the learning objectives that have not been accomplished. Teachers have tried to improve students' mathematical abilities through giving practice questions that demand their mathematical abilities. However, students' mathematical ability is still low, especially since the Covid-19 pandemic hit. Their learning motivation is very lacking because they are addicted to gadgets. About 15% of students who follow mathematics learning well, the rest do not respond to understand or not the material delivered by the teacher. The teacher delivered the material in accordance with the worksheets from MGMP and the mathematics package book. The obstacles faced during teaching material were the provision of media or teaching aids that would be used. The capabilities of students at the school have not been taken into consideration in the worksheets that were obtained from the publisher. Therefore, e-modules are needed that are designed according to the characteristics of students, involve technology, and train mathematical ability. The material given is a system of two-variable linear equations with concept maps as in Figure 2.
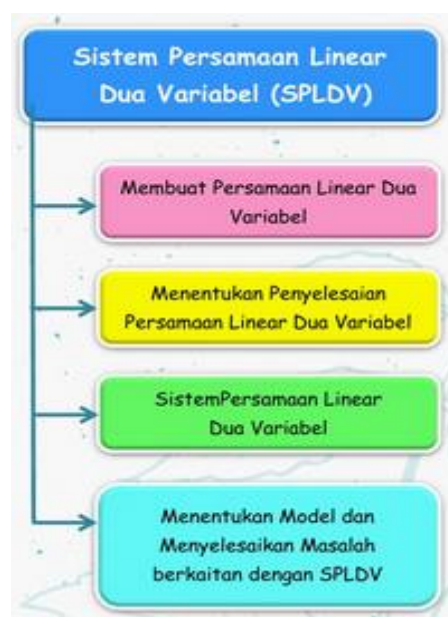

Figure 2: Concept Map of a System of Two-variable Linear Equations

Based on Figure 2, it can be seen that learning a system of two-variable linear equations begins by making two-variable linear equations and determining their solution. The next discussion is about the system of two-variable linear equations, determining models, and how to solve them (graphing, substitution, and elimination methods). Learning continues by solving problems related to two-variable linear equation systems.

Student analysis activities are carried out in grade VIII aged 13 – 15 years. Piaget revealed that children at that age have cognitive development that is at the stage of formal surgery. At the stage of formal surgery, children are able to solve problems

and communicate using abstract things. e-Modules that are colorful, have captivating images, incorporate contextual issues, offer students the chance to collaborate with peers to solve mathematical puzzles are essential for academic achievement. As a result, different intelligences-based e-modules are created with the ability to adapt to the needs of talkative students. If there are some students who like to study individually, e-modules based on multiple intelligences will also lead students to actively construct their knowledge independently.

B. Development or Prototyping Phase Results

The cover of the compound intelligence-based e-module combines different types and sizes of fonts. The cover of the e-module presents the title of the material to be studied, the identity of the author, and the educational unit. For more details, the cover of the e-module can be seen Figure 3.
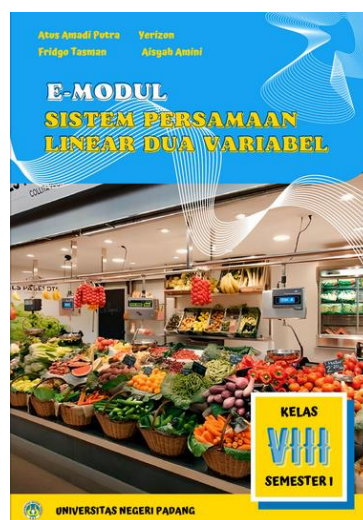

Figure 3: Cover e-Module

The e-module contains instructions on how to use the e-module for teachers and students as shown in Figure 4.

Figure 4: Instructions for Use of e-Module

Learning activities in e-modules based on multiple intelligences consist of several student activities. Footage of student activities in each activity can be seen in Figure 5.

Figure 5: Learning Activities in e-Module

To strengthen students' understanding, at each meeting students work on exercises on the e-module. Students can also see a summary at the end of the learning activity, as seen in Figure 6.
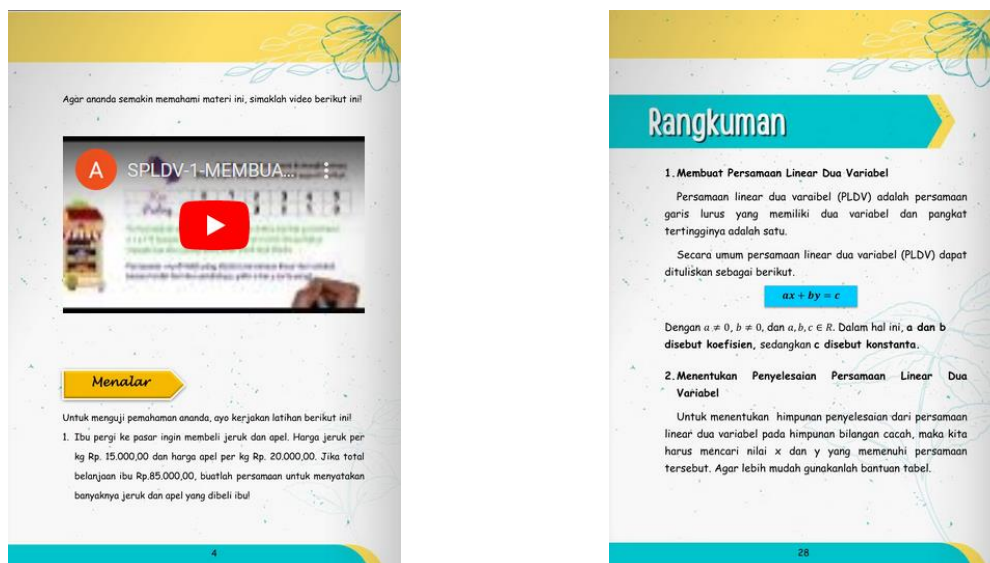

Figure 6: Exercises and Summary on e-Module

At the end of the e-module, there is an answer key for each learning activity, as seen in Figure 7.
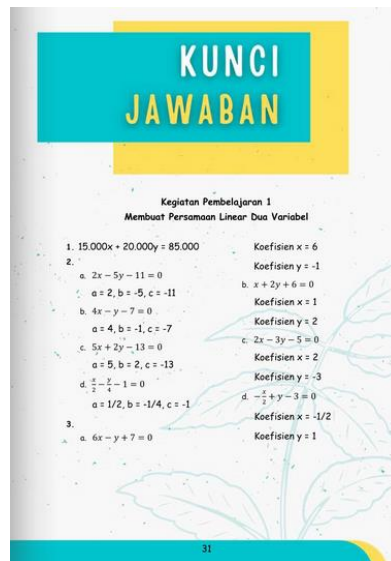
Figure 7: Answer Key on e-Module

Subsequently, the e-module underwent validation through several topic experts. The aspects assessed on the e-module are the aspects of content, language, didactics, and graphics. From these results, the validation by experts was obtained that the e-module was valid.

C. Assesment Phase Results

One to one evaluation activities were carried out to three grade VIII students of SMPN 7 Padang who have different abilities. The e-module work begins with the activity of students observing and assessing the e-module from the cover page and instructions for its use. Students' responses at the one to one evaluation stage are outlined in Table 1.

Table 1: Student Responses in the One to One Evaluation Stage

No	Questions	Ability		
		High	**Moderate**	**Low**
1	Do you think the writing on the e-module is clear and readable?	It is clear and readable.	Clear and readable.	Yes, it is very clear and readable.
2	Can you understand the language and terminology used in the e-module so that you understand the material of the two-variable linear equation system?	Yes, I can understand that.	Enough to understand.	Yes, I quite understand it.
3	Is there a typo error such as a missing letter in a word?	Yes, there is no video on the front of the e-module.	On the front page there is a sentence "watch the following video!" but there is no video.	There is, on the front page there is no video.
4	Are the images on the e-module clear and help you understand the problem presented?	Very helpful because they are interesting.	Yes, they are.	Yes, they are very helpful.

5	Do you think the placement of images on the e-module is appropriate?	Yes, that's right.	That's right.	Yes, that's right.
6	Are the instructions contained in the compound intelligence-based e-module clear and complete?	They are obvious.	They are quite clear and complete.	They are obvious.
7	Is the display of the e-module interesting and motivates you to learn mathematics? Explain what you think about the overall appearance of the e-module!	The e-module display is attractive and complete like a book. I can learn from e-modules only.	Yes, because it is easy to carry anywhere.	The e-module is very interesting and I can understand it.
8	Can e-modules make it easier for you to use them in class?	Yes, because the e-module can be opened on a mobile phone.	Yes, it's very easy.	Yes, it has.
9	How many times do you have to read the problems in the e-module to be able to understand the problems given? Explain your answer.	Three times because I haven't understood if read once.	Two to five times.	I read it three times in order to understand the problem.
10	What difficulties did you encounter while studying with the help of e-modules?	Long waiting for the writing to appear on the next page.	None.	None.
11	Explain your thoughts about the questions contained in the e-module!	Interesting question and I can understand.	Quite challenging.	The problem is quite challenging.
12	Give your suggestions on improving the e-module based on the difficulties you experienced while working on the e-module!	Not long waiting for the article to appear on the next page.	None.	None.
13	Can the questions contained in the e-module be done during the time provided?	Yes, it can be done.	Yes, I can work on it.	Yes, it can be done.
14	What do you think about learning mathematics using e-modules based on multiple intelligence?	It is easy to understand and makes me understand the material of the two-variable linear equation system.	Interesting, because I can learn with e-modules anytime and anywhere.	Learning mathematics using e-modules is very interesting to me.

Overall, high, medium, and low ability students in the one to one evaluation stage can understand the problems in the e-module. In addition, the colorful display of the e-module attracts students to read and understand the problems that exist in the e-module. Six students with various levels of abilities from class VIII of SMPN 7 Padang utilized the e-module in small group evaluation. This activity ended by filling out a questionnaire on the practicality of e-modules based on multiple intelligences then

continued with an interview. Student responses at the small group evaluation stage are described in Table 2.

Table 2: Student Responses at the Small Group Evaluation Stage

No	Questions	Group	
		1	**2**
1	Do you think the writing on the e-module is clear and readable?	The writing on the e-module is very clear and readable.	Yes, it is clear and legible.
2	Can you understand the language and terminology used in the e-module so that you understand the material of the two-variable linear equation system?	The language is very easy to understand.	Yes, we can understand that.
3	Is there a typo error such as a missing letter in a word?	There was no fault.	None.
4	Are the images on the e-module clear and help you understand the problem presented?	The pictures on the e-module are very clear and help us understand the problem.	Yes, the images are clear and very helpful.
5	Do you think the placement of images on the e-module is appropriate?	Yes, that's right.	We think it's appropriate.
6	Are the instructions contained in the compound intelligence-based e-module clear and complete?	The instructions on the e-module are precise and complete.	Yes, instructions for using the e-module are understandable.
7	Is the display of the e-module interesting and motivates you to learn mathematics? Explain what you think about the overall appearance of the e-module!	Very interesting, because the material and sample questions in the e-module are complete.	Interesting, because it's like turning the pages of an actual book.
8	Can e-modules make it easier for you to use them in class?	Of course.	Yes, it is easy to use.
9	How many times do you have to read the problems in the e-module to be able to understand the problems given? Explain your answer.	Repeatedly.	Two to three times.
10	What difficulties did you encounter while studying with the help of e-modules?	None.	We had difficulty in understanding the story problem in the e-module.
11	Explain your thoughts about the questions contained in the e-module!	The example of the problem is easy to understand.	Quite challenging.
12	Give your suggestions on improving the e-module based on the difficulties you experienced while working on the e-module!	We did not find any difficulties in using the e-module.	None.
13	Can the questions contained in the e-module be done during the time provided?	Workable.	Yes, it can be done.
14	What do you think about learning mathematics using e-modules based on multiple intelligence?	Learning mathematics using e-modules becomes more interesting and easy to understand.	Learning mathematics becomes exciting and understandable.

The multiple intelligences-based e-module has clearly delighted practical requirements, as evidenced by the description of student answers throughout both the one to one and small group evaluation stages.

D. Discussion

Each student's intelligence is different (Abenti, 2020; Alsalhi, 2020) so they have unique ways of learning (Abenti, 2020). This determines students' chances of learning success (González-Treviño et al., 2020). Thus, students' multiple intelligences need to be considered because they impact educational communication (Abenti, 2020) and students' intellectual abilities in the classroom (Almeida et al., 2010). Previous studies found that implementing multiple intelligences in the classroom can improve students' academic development (Ghamrawi, 2014). Similar to what we found, when students with mathematical logical intelligence attempt to answer the given mathematical problems, our e-module helps them. Students are capable of performing mathematical operations as well as calculations, measurements, consideration of propositions and hypotheses. Usually people with this intelligence have logical and scientific thinking patterns.

The availability of significant pictures and educational videos in this e-module further assists students with visual spatial intelligence. It is relevant to the previous studies which they found that the second type of intelligence possessed by students is visual spatial intelligence. In this case, students have the ability to see an object in detail (Ebadi & Beigzadeh, 2016; Kirkgöz, 2010). Learning using this e-module is done in groups. Students discuss with their respective group members in solving the problems presented in the e-module. So that students with interpersonal intelligence will be helped by this e-module. It is consistent with earlier research that showed a sufficiently high percentage of interpersonal intelligence (Gürkaynak, 2015).

On the other hand, students with intrapersonal intelligence prefer to learn by themselves. However, this can be overcome by using this e-module because there are already instructions for each learning activity and learning videos on the e-module. As the content is accessible by smartphone or laptop, students have access at any moment from everywhere. This type of intelligence in previous studies has a fairly small percentage (Ebadi & Beigzadeh, 2016; Gürkaynak, 2015; Taaseh et al., 2014). This intelligence allows students to recognize their own patterns and distinctions from other people as well as to comprehend themselves (Ebadi & Beigzadeh, 2016; Taaseh et al., 2014). A study reported that students' dominant intelligences were kinesthetic, interpersonal, intrapersonal and musical (Carlín et al., 2013). This can support differentiated learning in the classroom by considering students' multiple intelligences (Adcock, 2014).

Drawing from the aforementioned explanation, it is possible to conclude that teaching mathematics with a concentrate on multiple intelligences assists students advance their educational achievement. There exists a considerable positive correlation between academic accomplishment and multiple intelligence (Ayesha & Khurshid, 2013). For example, studies by Panjaitan (2023) and Yerizon (2023) found that students may strengthen their critical thinking and mathematical literacy through multiple intelligences-based mathematics instruction. The results of Anwar's (2020) study also showed that 19.35% of students in the medium category, 64.52% of students in the high category, and 16.13% of students in the very high category after using teaching materials based on multiple intelligences on trigonometry material.

Furthermore, considering that it incorporates a variety of intelligences and learning styles, Gürkan (2019) found that using multiple intelligences positively affects students' interest and participation in the learning process. The significance of using multiple intelligences in mathematics teaching materials must therefore be understood by educators.

Due to the fact that e-modules include case studies, descriptive pictures, and videos that illustrate the subject matter, they promote student-centered learning and make learning more creative and enjoyable (Aji & Bhakti, 2021). When viewed from the students' responses in our study, they liked learning mathematics, especially on the material of the system of linear equations of two variables using e-modules based on multiple intelligences. Students felt that learning mathematics became exciting, interesting, and easy to understand. The result relates to the assertion made by Wolla (2017) that e-modules greatly enhance students' comprehension of the subject content.

CONCLUSION

This multiple intelligences-based e-module received a good response from students. It can be seen from the results of student responses in both one to one evaluation and small group evaluation. They argue that learning a two-variable linear equation system using a multiple intelligences-based e-module becomes interesting and easy to understand. By using this e-module, students can access learning at any time and from any location. Therefore, it is recommended for teachers to design and use multiple intelligences-based e-modules for other math topics.

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