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THE DEVELOPMENT OF E-MODULE MATHEMATICS BASED ON CONTEXTUAL PROBLEMS

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Abstract:
Student' mathematics learning outcomes in the era of the industrial revolution 4.0 still have many problems. Meanwhile, teachers are required to be able to make innovations by involving technology. The purpose of this study is to produce a valid and appropriate mathematics e-module based on contextual problems. The research method used is Research & Development with the ADDIE model. The research participants were 78 students in 7th grade junior high schools who were selected purposively. The results showed that the e-module mathematics based on contextual problems developed was feasible to be used to improve student learning outcomes on set material. Student learning outcomes increase effectively due to the active involvement of students' mathematical knowledge, which is built from a digital real-life context. Researchers recommend that teachers and practitioners familiarize themselves with the use of e-module by integrating them with math problems that are close to students' lives.

Keywords: e-module, contextual problems, learning outcome, mathematical knowledge

1. Introduction

Mathematics education has changed in the learning approach, along with the times in the era of the industrial revolution 4.0 (Tubb et al., 2020; Widjaja, 2013). These changes occur mainly in the use of technology by teachers (Karaoglan-Yilmaz et al., 2018). Electronic system-based technology is the most effective approach applied by teachers in learning mathematics at the junior high school level. This effectiveness occurs because electronic-based technology is most adaptable to student learning environments (Nasrudin et al., 2018). In addition, electronic-based technology can optimize student competence more optimally than other types of technology (Higgins et al., 2016).

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The use of electronic-based teaching materials in learning is a necessity so that junior high school students understand mathematics subject matter more deeply. Teaching materials in the form of an e-module provide an advantage over the print module because students are given the opportunity to repeat the subject matter independently as needed (King & Robinson, 2009; Thuneberg et al., 2018). Electronic modules are teaching materials in an electronic format that are systematically arranged in the form of audio, animation, and navigation. The advantage of using an electronic module is that students have more opportunities to study independently (Sugianto et al., 2017). Although it has various advantages, the electoral module also has various disadvantages. Based on previous studies, it shows that the main weakness of the electronic module is that the problems given to construct knowledge are not close to students' daily lives.

Salavera, Usán, & Teruel (2019) stated that in order for student knowledge to be effectively constructed from the daily lives of students, the problems presented during learning must start from contextual problems. By posing contextual problems, students are gradually guided to master mathematical concepts. Providing contextual problems makes students fully involved in important activities that help students relate academic learning to the real-life contexts they face. By linking the two, students see meaning in schoolwork. This occurs when students are actively involved in selecting, arranging, organizing, touching, planning, investigating, questioning, and making decisions (Widjaja, 2013). Thus, the involvement of contextual problems in the e-module is a learning need so that students can more easily construct mathematical knowledge.

The results of previous studies show junior high school students fail to construct mathematical knowledge. Jannah & Prahmana (2019) stated that this failure could be seen from the student learning outcomes. The results of the study Ramadianti, Priatna, & Kusnandi (2019) showed that the students' mathematics learning outcomes were low because students experienced misconceptions during conventional learning. On the other hand, low mathematics learning outcomes are mainly due to low student motivation. According to Reeder (2016), mathematics learning activities that are not meaningful result in low student learning outcomes.

Therefore, in this era, an e-module of mathematics based on contextual problems is needed for students. It is hoped that through the e-module mathematics based on contextual problems, students try to connect and construct a theoretical or abstract understanding of concepts according to the nature of mathematics and the experiences they have had. The experience in question is all activities that students have experienced before learning or during learning. Thus, the construction of students' mathematical knowledge through contextual-based learning experiences will be able to foster better student understanding. Thus, the aim of this study is to develop a mathematics e-module based on contextual problems for junior high school students.

2. Literature Review

2.1 Mathematics E-Module

An electronic module or e-module is a technology-based learning tool or tool that contains materials, methods, limitations, and ways of evaluating, which are designed systematically and attractively to achieve the expected competencies according to the level of complexity in digital form. The material in the e-module is designed systematically based on a certain curriculum and is packaged in the smallest learning unit and allows for independent study in units of time (Purwanto & Lasmono, 2007). E-module has the characteristics that users can use it independently, unified content, stand-alone, adaptive, and friendly (Daryanto, 2013). The e-module has several advantages compared to the print module, namely the e-module is more interactive, making it easier for students and teachers to navigate, allows displaying / loading images, audio, video, and animation and is equipped with formative tests / quizzes that allow automatic feedback immediately.

Applications that can be used to create an e-module include Exelearning (Pilt et al., 2014); Kvisoft Flipbook Marker (Sugianto et al., 2017); 3D Page Flip Professional (Ferdianto et al., 2019); and Flip PDF Professional. Among the e-module creation applications, the Flip PDF Professional application has the advantage of being easy to use because it can be operated for beginners who have not mastered the HTML programming language. PDF Flip Professional is a feature-rich flipbook maker that has a page editing function. This application can create interactive book pages by inserting multimedia such as images, videos from YouTube, mp4, audio-video, hyperlinks, quizzes, flash (Professional, 2019).

2.2 Contextual Problems

Contextual problems are a problem that references some existing settings outside of pure mathematics, provides motivation, increases student engagement, and develops students' capacities to apply mathematics to extra-mathematical situations in the future (Boaler, 1993). Meyer et al. (2001) stated that contextual problems could serve as an anchor that students use to interpret student learning outcomes in mathematics learning. Contextual problems are generally divided into two, namely contextual problems on cognitive achievement and contextual problems on social achievement. Contextual problems with cognitive achievement lead to low attainment; students do not understand the problem situation, and therefore cannot show their full potential in solving problems from everyday life. Contextual problems related to social, students find it difficult to adapt to the main socialization context of students consisting of family, school, and classmates (Salavera et al., 2019).

2.3 Learning Outcomes

In general, the understanding of learning outcomes is a change in behavior and overall abilities possessed by students after learning, which is in the form of cognitive, affective, and psychomotor abilities caused by experience and not just one aspect of potential. The first domain is concerned with the acquisition of knowledge and understanding, whereas affective learning involves values, attitudes, and behavioral intentions (Gatti et al., 2019). Student learning outcomes provide a generalized measure of student achievement that provides a complete picture of student progress and completion in the education system. Although traditional educational theory focuses primarily on the cognitive outcomes of learning and understanding, affective learning also appears to influence education and learning positively (Lithner, 2017).

Assessment of student learning outcomes includes three domains, namely cognitive, affective, and psychomotor. Cognitive assessment is demonstrated by the retrieval of knowledge and intellectual skills: understanding information, organizing ideas, analyzing and synthesizing data, applying knowledge, choosing among alternatives in problem-solving, and evaluating ideas or actions. Affective assessment is shown by behaviors that show attitudes of awareness, interest, attention, attention, and responsibility, the ability to listen and respond in interactions with others, and the ability to show characteristics or attitudinal values that are appropriate to the exam situation and learning area. Psychomotor assessment is shown by physical skills: coordination, agility, manipulation, grace, strength, and speed. Actions that demonstrate fine motor skills such as the use of instruments or precision tools include actions proving gross motor skills such as the use of the body in dance or athletic performances (Gerritsen-van Leeuwenkamp et al., 2019).

3. Materials and Methods

3.1 Research Methods

In this study, the development of a mathematics e-module based on contextual problems was carried out using the R&D (Research & Development) research method. The type of R&D used is the ADDIE model. The stages of the ADDIE model development consist of Analysis, Design, Development, Implementation, Evaluation (Molenda, 2003).

The stages of e-module development follow the ADDIE Model product development steps, namely: Analysis, Design, Development, Implementation, and Evaluation. In the Analysis stage, the researcher observes the learning needs, the curriculum used, and the characteristics of students in school. At the Design stage, the researcher makes an initial e-module design that has contextual problems, identifies standard competencies, and learning materials. This is done so that the e-module design and contextual problems are made in accordance with the scope of student problems in the curriculum aspects. At the Development stage, the initial e-module design is validated by experts to assess the suitability of the e-module being developed. It is also included at this stage that the researcher gets input or suggestions from experts. At the Implementation stage, the researcher implemented the e-module in the class in several meetings. At the Evaluation stage, researchers reflect on the application of the e-module and analyze the effectiveness of its application. After the five stages are carried out, the researcher gets e-module mathematics based on contextual problems.

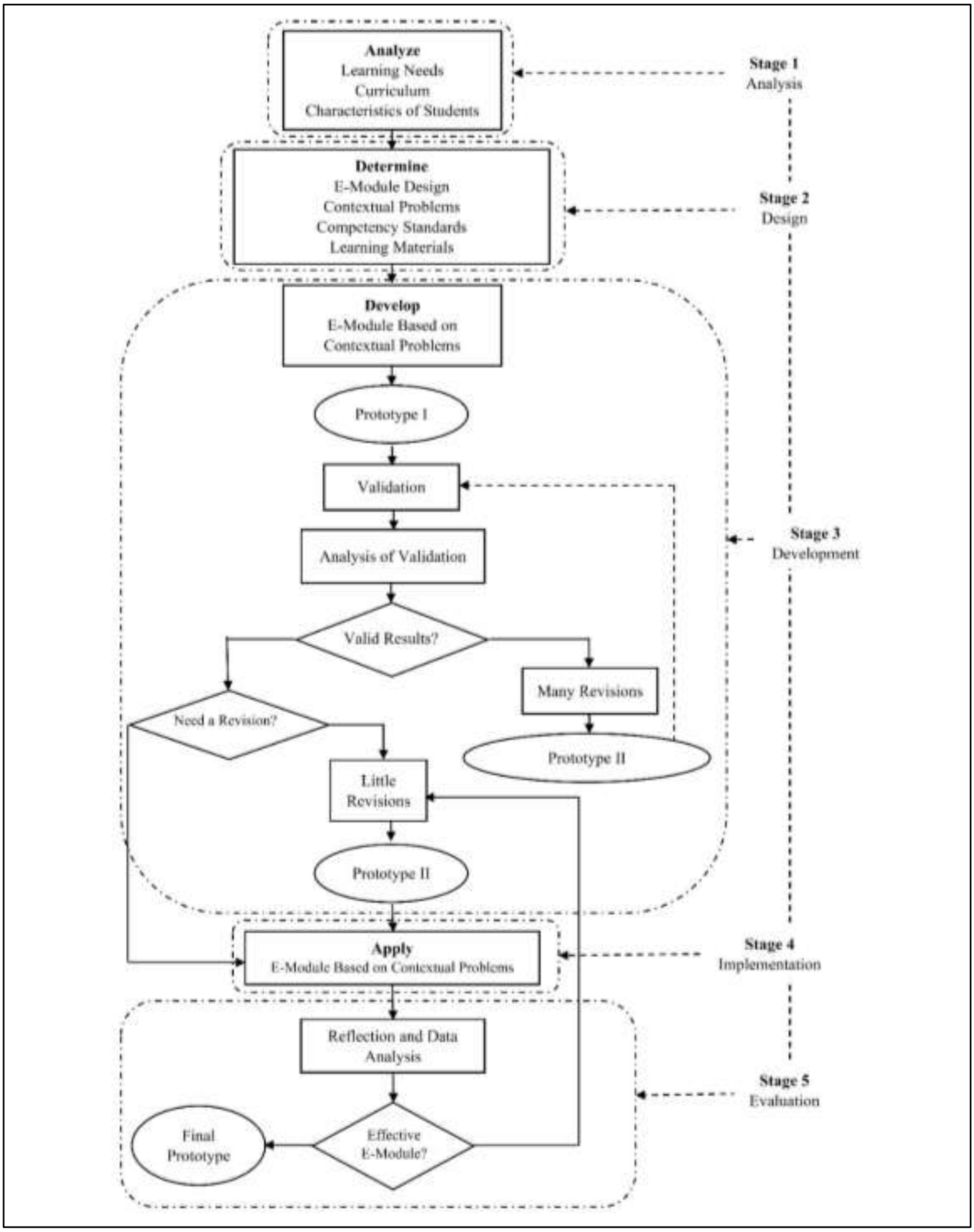

Figure 1: Stages of E-Module Development

3.2 Research Participants

The research participants consisted of a total of 78 junior high school students from two 7th grade students at SMP PGRI 6 Malang, Indonesia. Participants were selected using a purposive sampling technique. This is done by researchers to control external variables. Namely, students who are selected as participants are students who have never received learning in the form of giving an e-module of mathematics based on contextual problems (Creswell, 2012). Meanwhile, the determination of the two classes as a sample was determined randomly. Respectively, in class 7-A and 7-B, with a total of 38 students selected as the experimental class and the control class. The experimental class is a class that applies to learn using the e-module and the control class does not use it.

3.3 Instruments and Data Collection Techniques

The research instrument consisted of observation sheets, questionnaires, and learning outcomes tests. The observation sheet is used to get the initial problems faced by students and teachers. This observation sheet contains field notes by the researcher. Meanwhile, a questionnaire was used to assess the validity of the e-module design by experts. This questionnaire was filled in by three validators (media expert, material expert, and linguist). The questionnaire contains a total of 21 statements with 7 statements each about the construction of contextual problems, mathematical content, and language. This questionnaire was given to the experts after the researcher made the initial e-module design. The learning outcome test is used to obtain student ability data after getting the application of learning using an e-module. This test contains 10 math problems on the set material.

3.4 Data Analysis Technique

In this study, the research data is divided into two, namely quantitative data and qualitative data. Quantitative data in the form of validation results from experts were analyzed using product validity categories, as in Table 1 (Arikunto, 2010). Meanwhile, quantitative data in the form of learning outcomes were analyzed using a t-test separated variance paired. This is done to assess the effectiveness of the application of the mathematics e-module based on the contextual problems developed.

Table 1: Validity category

Perc. (%)	Validity Level	Category
76-100	Valid	Feasible/no revision needed
51-75	Enough Valid	Quite feasible/partial revision
26-50	Less Valid	Less feasible/partial revision
<26	Invalid	Infeasible/total revision

On the other hand, qualitative data is in the form of observations or preliminary studies in the form of suggestions or input from the validators on the e-module design. This qualitative data is analyzed using data organizing, synthesizing data, presenting data, and making conclusions.

4. Results and Discussion

4.1 Analysis Stage

The results of school observations on learning mathematics show that more than 80% of students have difficulty learning mathematics. Many students are less interested in learning mathematics so that it affects student learning outcomes in the learning process. This is because the module used by teachers are still conventional. Thus, students do not study mathematics. This is because the module used do not have mathematical problems that are close to student life. Widjaja (2013) stated that the teaching materials used by students are close to his or her life, then the problems that become materials for constructing knowledge must be contextual problems.

Meanwhile, the curriculum used in schools is Curriculum 2013. According to Kemendikbud (2013) that Curriculum 2013 has the main character in constructing knowledge. Namely, the mathematics problems given to students must be accessible in the student's Zone of Proximal Development (ZPD). Therefore, the problems from the results of these observations can be overcome by creating a mathematics e-module based on contextual problems that can be used by teachers and students.

4.2 Design Stage

The initial design of a math e-module based on contextual problems was done through the Microsoft Publisher application and then saved it in pdf format. The module in pdf format is then inserted into the Flip PDF Professional application to become the final output of the e-module in the form of a flip page. The flip page in the form of an e-module cover can be seen in Figure 2. Additional media to complement the module, such as audio, video, weblinks, and formative questions are included using the application.

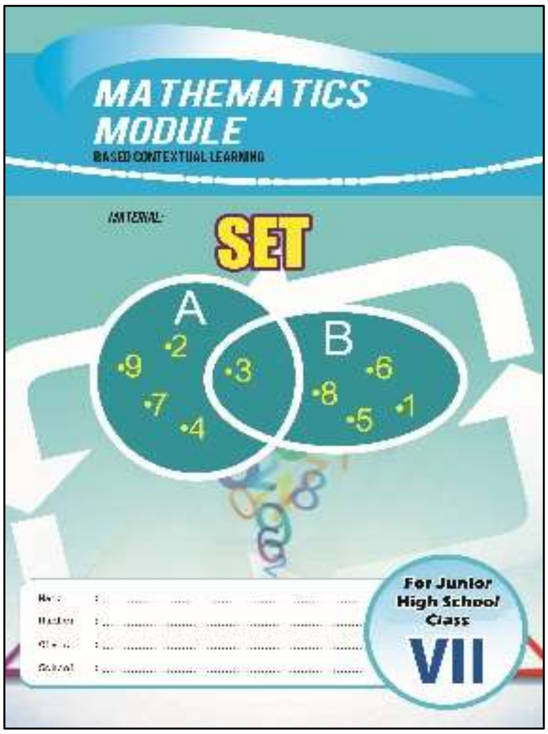

Figure 2: Mathematics Based on Contextual problems E-module Cover

From the subject matter analysis carried out, e-module are developed on the set material. Contextual problems are arranged in each sub-material. This is done so that students have experience in the form of mathematics learning activities that are close to life in constructing knowledge about sets. Figure 3 shows the learning activities carried out by students using contextual problems in the set material.

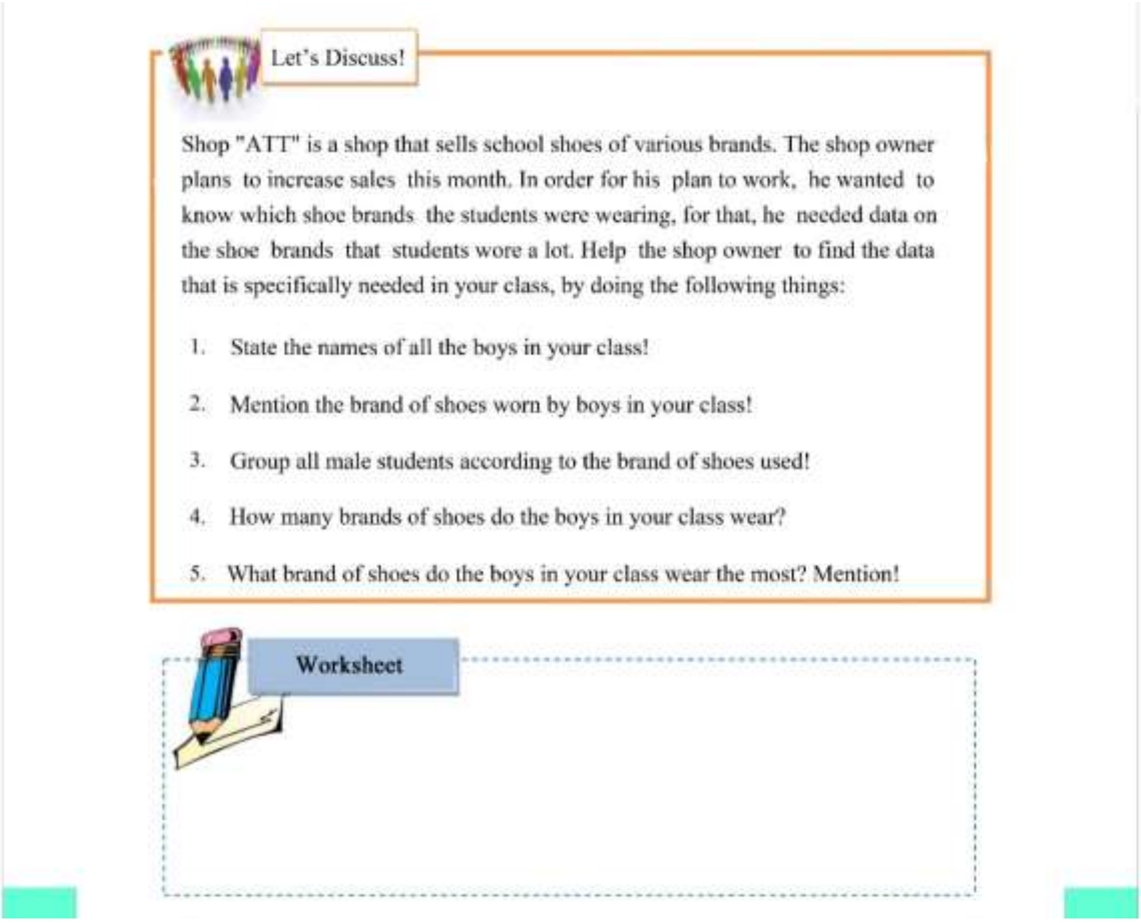

Figure 3: Activities of Constructing Mathematical Knowledge through Contextual Problems

4.3 Development Stage

After the initial e-module design has been completed, this initial design is validated by the expert. The aspects that are validated include the construction of contextual problems, mathematical content, and language. Meanwhile, the experts who validated were three lecturers in the field of mathematics education.

Table 2: Validation Results of E-module Mathematics Based on Contextual Problems

No.	Aspect	Perc. (%)	Validity Level
1	Construction of contextual problems	80	Valid
2	Mathematical content	78	Valid
3	Language	77	Valid
Average		79	Valid

Table 2 shows the average percentage value of the validity of the e-module design in each of the development aspects by the three validators. The average percentage value on each aspect of the construction of contextual problems is 80%, mathematical content is 78%, and language is 77%. Meanwhile, the average score of all aspects is 79%. Based on the level of validity, the e-module design has a valid level. This means that the e-module design is suitable for use without making revisions. However, the validators provide suggestions so that the e-module being developed will be even better. These suggestions consist of an e-module given attractive motives for junior high school students, practice questions need to be added, and any images that appear need to be annotated. Based on these suggestions, the researchers made improvements so that the e-module has an even better quality.

4.4 Implementation and Evaluation Stages

At the implementation stage, the researcher divided the class into two groups, namely, experiment and control. Implementation of learning using mathematics E-module based on contextual problems was carried out for 11 meetings. Each meeting is conducted once a week. During the first 10 meetings discussing the sub-material of a set as follows, the definition of a set, notation, and set members, stating a set, an empty set and a zero set, and a universal set. Meanwhile, the last meeting was to provide learning outcomes tests. The results of the learning test in the experimental and control classes are used to conduct a final evaluation of the mathematics e-module based on contextual problems.

Table 3: Student Learning Outcomes Using the t-test

Group	n	Mean	Std. Dev.	t-test	t-table
Experiment	39	74.55	6.43	2.261	2.021
Control	39	63.65	5.98		

Table 3 shows the average student learning outcomes in the experimental class of 74.55 greater than the control class 63.65. Likewise, the t-test score of 2.261 bigger than t-table 2.021. Thus, the e-module mathematics based on contextual problems is effectively applied during learning on set material. According to Elissavet & Economides (2000) the results of the development of a standardized, measurable development product give positive results indicating that the product is suitable for use. Therefore, it can be said that the e-module mathematics based on contextual problems developed in this study is valid and suitable for use in the application of mathematics learning set material for junior high school students.

Previous studies have shown that the competencies of junior high school students developed through the integration of the use of e-module and contextual problems give positive results for students' conceptions of mathematics (Leow & Neo, 2014; Salavera et al., 2019). This happens because the concept of mathematics is built effectively through the use of an e-module. Meanwhile, the existence of contextual problems makes the conception of mathematics interconnected between one material and another. This makes students have complete mathematical thinking (Suwangsih, 2010; Tubb et al., 2020). During the learning process, students' cognitive activities are brought into a picture of their daily life activities. These cognitive activities include selecting, arranging, organizing, touching, planning, investigating, questioning, and making decisions from the real-life context of students (Widjaja, 2013). This makes students' mathematical knowledge built into long-term memory (Selvianiresa & Prabawanto, 2017).

5. Recommendation

Based on the results and discussion, the researcher recommends that teachers and practitioners construct students' mathematical knowledge through habituation of using e-module mathematics based on contextual problems, especially for students at the junior high school level. In addition, for policy makers, the results of this study imply that the use of mathematics e-module based on contextual problems is an effective solution to improve the competence of junior high school students in mathematics.

6. Conclusion

The conclusion in this study is that the developed e-module mathematics based on contextual problems is suitable for use in mathematics learning, especially for students at the junior high school level. Student learning outcomes are increased effectively through the application of e-module mathematics based on contextual problems. This effectiveness occurs because of the active involvement of students' mathematical knowledge, which is built from a digital real-life context. This makes the concept of mathematics interconnected from one concept to another.

Conflict of Interest Statement
The authors declare no conflict of interest.

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