



Development of General Arithmetic E-Module Based on APOS Theory to Improve Problem Solving Ability and Independence in Middle School and High School Students

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ABSTRACT

To learn about other parts of math, like how to work with numbers, you need to know arithmetic. The characteristics and concepts in mathematics are interrelated, therefore students need to acquire an introductory or basic grasp to assist in developing math skills (even if operations are considered basic stuff). This comprehension lays the groundwork for the acquisition of other mathematical talents, including problem-solving skills, which are crucial to a kid's success in school. Students and teachers alike rely heavily on online resources, yet this resource is not fully utilized in today's educational systems. In addition, not all online e-modules meet the standards of good e-modules, which results in subpar learning and makes it harder to accomplish certain educational goals. The goal of this research is to create an expert-based, user-friendly, and practical e-module for teaching elementary school mathematics that incorporates APOS theory in order to improve students' ability to learn independently and solve problems. This type of research is Design Research with the type of development studies divided into three phases, namely Preliminary research, Development or prototyping phase, and Assessment phase. Students from SMP Negeri 1 Winong, and MA Darul Ma'la made up the research sample. The data was gathered through a combination of tests, questionnaires, interviews, and observations. The study's findings demonstrate that the generated e-modules are of sufficient quality in terms of being valid, practical, and effective. validated by material experts and media experts, including lecturers and teachers, so that this e-module is considered valid by material experts and media experts, practical by lecturers, teachers, and students who use it through questionnaires, and effective based on problem-solving abilities and student learning independence after implementation.

Introduction

One of the factors that causes students to have difficulty learning mathematics is that they do not master the previous concepts used in the material being studied. One of the

materials that is considered difficult is algebra, where the BSNP from 2015 to 2019 in SMA for the percentage of absorption has increased and decreased. Every year the national exam has indicators that change; this is one of the causes of changes in student absorption. Because the indicators change automatically, the questions being tested also change, and the student's understanding that was originally required about procedural and systematic matters becomes a high-level understanding that requires students to have the ability to solve problems. For example, in 2018, the indicator of solving problems related to geometric series (37.58) changed to solving contextual problems related to geometric series (40.44) in 2019. Even though there was a change in the indicators, the results have increased, while other types of questions on infinite geometric series and non-routine problems were found to have a low percentage (4.08). This shows that students are required to have problem-solving abilities with a more complex understanding of concepts as seen from the higher types of questions tested.

This is supported by the preliminary research conducted by the researcher, as seen from the work of high school students with the problem "A geometric sequence is formed from a rope that is cut into 3 parts. What is the length of the rope if the shortest rope is 3 cm and the largest is 48 cm? with the results of students who are still wrong in identifying problems and using formulas. This does not only happen at the high school level but also for class VIII students of SMP Negeri 1 Winong who still make mistakes in the process of operating on mixed numbers, decimal numbers, and ordinary numbers, where problem-solving skills in this material should have been completed while in elementary school. This shows that arithmetic material is the basic material that must be mastered by someone to be able to study other mathematical material and develop other mathematical abilities, and arithmetic material is always involved in learning mathematics from elementary to high school levels. Imagine if someone who does not yet have sufficient knowledge and skills in addition operations on whole numbers is asked to complete addition operations on mixed numbers or multiplication. He or she will find it difficult to complete them. Understanding of previous material is one of the success factors for students in learning mathematics. Initial ability is one of the internal factors that influences success in learning mathematics, in addition to motivation, study habits, learning independence, and so on (I. Purnamasari & Setiawan, 2019:209).

One of them is the ability to solve problems, which, according to Posamentier (2010), is not only a goal of learning mathematics but also the core of it (Khomsiatun & Retnawati, 2015:95-96). So that it can be said that the students from the previous paragraph have discussed the results of student work where there was an error in writing the known elements of the problem and applying the formula to solve the problem, therefore it can be concluded that there is confusion in understanding for solving the given problem, especially school arithmetic material, so it can be said that students' problem-solving abilities are still lacking.

In this research, APOS theory is used as a supporting theory in the preparation of e-modules that are expected to improve students' problem-solving abilities. This study focuses on the implementation of APOS Theory in e-modules with school arithmetic material because APOS Theory is a theory that explains how to learn mathematical concepts with

APOS (Action, Process, Object, and Scheme) steps. This theory focuses on modeling what may occur in a person's thinking process when studying mathematical concepts (Arnon et al., 2014:1). The framework in question encourages students to understand mathematical ideas and hone problem-solving skills. This is because the APOS theory is one of the constructivist theories that form mental constructions, that is, concepts are first understood in the form of constructs as actions (actions), actions are contemplated as processes (interiorized), processes are encapsulated into objects (encapsulated), and objects are described again (interiorized). de-encapsulated), which becomes a process, so that finally actions, processes, and objects are arranged into a scheme that allows it to occur. When a person understands mathematical ideas or mathematical concepts, the theory can help someone develop problem-solving abilities, which are needed to overcome difficulties in learning school arithmetic and develop an independent learning character. The e-module developed is in the form of an electronic reference module that can be used as a reference for studying school arithmetic at the elementary, junior high, and high school levels of education, which is assisted by a Learning Management System (LMS) with a platform called Google Classroom due to the use of technology and the internet in Indonesia for aspects Education is still low compared to the entertainment aspect (Asosiasi Penyelenggara Jasa Internet Indonesia, 2018) and the reason for choosing the LMS used for this research is that it is a web service that can be accessed for free and is easy to use to create, give, and grade assignments online, where assignments and materials can be made via Google Drive and Gmail is used to facilitate interactions between students and teachers. Google Classroom can be accessed via laptops or smartphones, which makes students take advantage of technology to learn, especially mathematics.

In the 2013 curriculum for learning mathematics, apart from the cognitive aspects that are considered, the affective aspects of students must also be considered, and all levels of education in Indonesia must include character education in the learning process. Independence is one of the characteristics in character education possessed by students. The definition of learning independence according to Wongsri, Cantwell, and Archer is a learning process in which individuals have a sense of responsibility in designing, implementing, and evaluating the learning process (Hendriana et al., 2017:229). The application of character education in learning mathematics means that learning mathematics is no longer only to support the development of the cognitive domain but also to develop the affective and psychomotor domains (Prabowo & Sidi, 2010:167).

Instilling the character trait of learning independence is not an instant thing; it takes applying character in everyday life, which gives a person their identity. This is what distinguishes between character education and moral education. This is also in line with Rachman (Prabowo & Sidi, 2010:170), who said that character education must be carried out with 3K, namely consistent, continuous, and consistent, as a conscious and planned effort to grow and sculpt the characters in students. According to Alan Schonfeld (Prabowo & Sidi, 2010:170), what is important is not ability but rather attitude, and his research shows that without adequate prior knowledge of mathematics, students can be successful in mathematics as long as they have characters and attitudes that support learning mathematics. So that in this study, in addition to paying attention to the implementation of

the APOS Theory, it also makes learning mathematics a tool for developing student character, one of which is the character of learning independence.

So this research focuses on the implementation of APOS theory in e-modules with school arithmetic material. The e-module being developed is in the form of an electronic reference module that can be used as a reference for studying school arithmetic at the elementary, junior high, and high school levels. It is assisted by a learning management system with a platform called Google Classroom. However, the E-module is not necessarily developed with the help of technology alone, but its preparation is based on APOS Theory, which has a framework of thinking that allows a person to understand mathematical ideas or mathematical concepts. This theory can help a person develop problem-solving abilities that are necessary to overcome difficulties in studying school arithmetic and developing the character of independent learning. Based on the description above, research is being conducted with the hope of producing a reference e-module that contains problem-solving abilities and the character of independent learning in quality school arithmetic material. E-modules are said to be of high quality if they meet the valid, practical, and effective requirements. This is based on Nieveen (1999: 126) to determine the quality of product development results seen from the results of the data analysis obtained in terms of aspects of validity, practicality, and effectiveness. so that the formulation of the problem in this study is:

- a. How valid is the arithmetic e-module loaded with APOS theory to improve problem-solving abilities and independent learning?
- b. How practical is the arithmetic e-module loaded with APOS theory to improve problem-solving abilities and independent learning?
- c. How effective is the arithmetic e-module loaded with APOS theory to improve problem-solving skills and independent learning?

Research Methods

The stages carried out in this research follow the design research type of development studies, which divides into three phases, among others (Plomp, 2013:19):

1. Preliminary research: in this phase, the things that need to be done by researchers are
 - a. Choose the developed material.
The materials chosen are numbers, number operations, number patterns, and number sequences and series.
 - b. Determine the purpose of the e-module being developed.
In determining the purpose of the developed e-module, refer to the learning objectives. In the 2013 Curriculum, learning objectives are determined based on core competencies and basic competencies.
 - c. Determine the support needed for the e-module.
In determining the support needed in the development of e-modules, checking the availability of supports such as the LMS used, Google Classroom, and the availability of the need to access Google Classroom from the user side, such as the internet, applications, and smartphones, as well as conducting field surveys and literature studies in which teaching material analysis is carried out, currently used in schools based on the APOS theoretical framework.
 2. *Development or prototyping phase, where the cyclic process occurs in the second phase.*
 - a. Compile / develop,
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In this case what is done to compile/develop among others

- 1) Compile a list of e-module requirements in order to find out the material that must be written and the sequence of the material in the order of related material from simple to more complex things.
- 2) Develop an outline of the contents of the e-module.
- 3) Formulate the basic competencies and indicators that must be achieved.
- 4) The preparation of material on the e-module in the form of a guide that makes it easier for students to understand concepts in arithmetic.
- 5) Designing activities that are adapted to the framework or theoretical stages of APOS with material and helping students' problem-solving abilities and student learning independence.
- 6) Preparation of practice questions in the form of description questions to help develop students' problem-solving abilities, as well as
- 7) The key is to find the answers to the formative test questions so that students can carry out independent learning evaluations.

b. Evaluate (formative evaluation),

Based on the formative evaluation stage that has been illustrated by Tressmer (1993), among others:

- 1) Self-evaluation, namely independent evaluation or screening using a list of important characteristics or design specifications, is carried out by researchers, and at the end of the process, an evaluation is carried out as material for improvement (revision).
- 2) Expert reviews, or expert reviews or focus groups in this case, will be validated with validation sheets by material experts and media experts, namely lecturers and teachers, and at the end of the process an evaluation is carried out as material for improvement (revision).
- 3) The one-to-one or one-to-one evaluation in question is implementing the e-module that has been prepared for representatives from the research subject group, and at the end of the process, an evaluation is carried out as material for improvement (revision).
- 4) Small group or micro evaluation, which implements e-modules in small groups to assess effectiveness and application of appeals (practically),
- 5) Field tests are situations where trials are carried out on large groups, and at the end of the trials, an assessment is made of the effectiveness and practicality of using the e-module.

c. Correcting or revising is done at the end of each formative evaluation stage.

3. The assessment phase where the final assessment stage is held is called a semi-summative evaluation to conclude whether the final product is as desired.

The research sample consisted of teachers and students from the research school. Two teachers were selected, consisting of one junior high school teacher and one high school teacher, to measure the practicality of the e-module. As for students selected for each level of junior high and high school. This research was conducted at SMP Negeri 1 Winong and MA Darul Ma'la Winong in the 2021-2022 academic year, semester 2. Data collection techniques

used in this study were validation sheets, problem-solving ability tests, teacher and student practicality questionnaires, independent learning questionnaires, and interviews. In the process of analyzing the data obtained, SPSS assistance was used in statistical tests.

Findings

The e-modules that have been developed in this study obtained valid evaluation results from experts and were practical for users, and they were effective in increasing the problem-solving abilities and learning independence of junior and senior high school students.

Quality

E-modules are said to be of high quality if they meet the valid, practical, and effective requirements. This is based on Nieveen (1999: 126) to determine the quality of product development results seen from the results of the data analysis obtained in terms of aspects of validity, practicality, and effectiveness. This is similar to what was done in previous research by Putri et al.(2019:244) in developing learning media to achieve learning goals properly. These materials can support learning effectiveness, so that learning media are said to be feasible if they meet valid, practical, and effective criteria.

Valid

The validity of the arithmetic e-module contains APOS theory to improve problem-solving skills and independent learning. An e-module is said to be valid if it fulfills the requirements of the e-module, which is stated to have good minimum criteria for use with a few revisions and has an average score with good minimum criteria from the validator. The average result obtained from material experts is 4.24, with very good criteria. While the average result obtained from the media expert validator is 4.10 with good criteria, Based on these results, the e-module can be said to be valid. Where the e-module has facilitated users to carry out construction according to the APOS stage, bringing up learning independence when reading the e-module and understanding its contents independently so that they can assess deficiencies in learning, find solutions for those deficiencies, and evaluate learning outcomes, as well as preparation that is adjusted with indicators of problem-solving abilities so as to improve problem-solving abilities. Validation is needed to perfect the developed media, which is validated by experts, including material experts and media experts (Ashnam et al., 2022:4). This is also in accordance with Nieveen (1999:127), who says that media are said to be valid if they meet two conditions: relevance based on content validity and construct (component) validity. As well as research steps conducted by Prayogi et al. (2018:48), his research to obtain a valid product validation was carried out by an expert (validator) with a discussion mechanism between the researcher and the validator, where suggestions and input from the validator were used as a follow-up to product improvement.

Practical

Practicality of the arithmetic e-module loaded with APOS theory to improve problem-solving abilities and independent learning E-modules are said to be practical if the average user response meets at least some good criteria. In this study, user responses were obtained from lecturers, teachers, and students using the e-module practicality sheet. Where the results of the assessment by lecturers and teachers were 4.54 with very good criteria, while the assessment by students at each stage can be seen in table 1.

Table 1 Practicality of the E-module at each research stage

Research Stage	level	Practical Value	Criteria
One-to-one	SMP	5,0	Very good
	SMA	4,7	Very good
Small Group	SMP	4,47	Very good
	SMA	4,42	Very good
Field Test	SMP	3,95	Good
	SMA	3,54	Good
Average		4,35	Very Good

It was found that the practicality assessment by junior and senior high school students was 4.35 with very good criteria. Where e-modules can be easily used by teachers and students. This can be interpreted to mean that the e-module is said to be practical, as is the opinion of Yamasari (2010) that the e-module is said to be practical if the results of the assessor's assessment state that the e-module can be used with little or no revision where the assessment is given by the assessor using the e-practicality assessment sheet. module (Rasyid et al., 2016:72). And Nieveen (1999:127) argues that it can be considered practical if the teacher (and other experts) or validators consider the media usable and easy for teachers and students to use the media in a way that is mostly in accordance with the developer's intentions. So that the practicality of the e-module is assessed from the responses of teachers and students in the use of e-modules, both in helping students use it and in understanding and making it attractive to use (Ilmi et al., 2021:5).

Effective

The effectiveness of the arithmetic e-module loaded with APOS theory to improve problem-solving abilities and independent learning The effectiveness of the e-module in this study was seen in the increased problem-solving ability and student learning independence. This is in line with research conducted by Dewi and Mashami (2019:258), who found that to see an effectiveness seen from the evaluation results by increasing a variable under study—for example, if students are being trained in problem solving skills—there is an increase in the evaluation results on problem solving abilities. Problem-solving abilities are evaluated using assessment techniques, namely problem-solving ability tests in the form of essay questions and independent learning in the form of a questionnaire. This evaluation was carried out with the aim of testing the e-module with the aim of obtaining information about whether the e-module can have a positive impact (Arnawa et al., 2019:291). Which is used to see the impact with the help of statistical calculations using the SPSS application.

Data on problem-solving abilities and learning independence obtained were tested for normality and homogeneity to determine which tests were used next. After knowing the normal data from the normality test and the homogeneous data from the homogeneity test, a paired t test is used, but homogeneous data is not a mandatory requirement, so if the data is normal, you can use a paired t test. This is in line with Hasyim et al., (2021:111-112) assertion that the absolute requirement for using parametric statistics is normally distributed data for the paired t test, but homogeneous data obtained after the homogeneity test is not an absolute requirement, so that if the data obtained is not homogeneous, you can use the paired t test. This was also conveyed by Rahayu et al., (2022:93), who stated that

homogeneous data is not an absolute requirement in the paired sample t test. Purnamasari et al., (2020:5) also stated that the absolute requirement for the paired sample t test is normally distributed data. In the problem-solving ability data obtained, it was found that there were normal and homogeneous data and that there were normal but not homogeneous data. Therefore, even though the data is not homogeneous but is normal, you can use the paired sample t test.

In junior high school students, it can be seen that the e-module can improve problem-solving skills; the value of sig (2-tailed) is $0.000 < 0.05$, and the average value before 70.5484 becomes 80.6129. So that after using the e-module, junior high school students show an increase in problem-solving abilities. This is in accordance with previous research that shows problem-solving-based e-modules for junior high school students are said to be effective in increasing problem-solving skills when 85% of students complete them individually (Ramadanti et al., 2021: 2742). This is also supported by previous research, namely that the problem-solving ability test has increased in terms of the results of changes from the initial and final test results in the moderate category (Ramadanti et al., 2021). This also happened to high school students. From the results of the paired t test, the sig (2-tailed) value was $0.000 < 0.05$, and from 38.8824 to 81.2647. It can be concluded that e-modules can improve problem-solving abilities. This is in line with the results of previous research showing that electronic-based teaching materials can improve problem-solving abilities (Hakim et al., 2021). The results of other studies show that using e-modules can improve problem-solving skills with an average n-gain of 0.57, which falls into the moderate category (Permana* et al., 2021). This is also in line with the results of research showing that using the APOS theory approach in learning activities can significantly improve mathematics learning abilities (Arnawa, Yerizon, & Nita, 2019:131).

If the paired sample t test is normal and not absolute, the sample is homogeneous. In contrast to the Wilcoxon test, where the Wilcoxon test is a non-parametric test used for a small number of research subjects (less than 30) and the data is not normal or homogeneous, This was also carried out in research with Uzel and Bilici, (2022:169), where the research sample included less than 30 individuals and the initial and final test data showed an abnormal distribution, so the Wilcoxon test was used. This was also conveyed by Usta and Yılmaz (2020:11), who noted that Wilcoxon is often used for data that is not normally distributed and the amount of data is small.

Learning independence is an intrinsic factor, or a factor that is contained in a person, that creates a sense of responsibility and confidence to achieve, which is important for students to have because they can discipline themselves to be responsible in the learning process (Cahyana et al., 2017:7039). In this study, students' learning independence was tested after using the e-module to determine whether it increased or decreased by carrying out statistical calculation processes. In the independent learning of junior high school students using the Wilcoxon test, the value of sig (2-tailed) was $0.000 < 0.05$, which means that there was a significant difference in the initial and final learning independence, and the previous average of learning independence was 103.5806 to 111.9677, so that the learning independence of junior high school students has increased after using the e-module. In the independent learning of high school students using the Wilcoxon test, it obtained a sig (2-

tailed) value of $0.000 < 0.05$, which means that there were significant differences in the initial and final learning independence and that the previous average of learning independence was 94.4412 to 114.8253, so that the learning independence of high school students has increased after using the e-module. From the test results on learning independence in junior and senior high school students, it can be concluded that e-modules can increase student learning independence. This is in accordance with the results of previous research that e-modules can increase learning independence (Widi Priyonggo & Sri Noor Asih, 2021) and with an increase in the moderate category, where 0.44 is obtained at the normalized gain index.

Discussion

APOS theory in the arithmetic e-module improves problem-solving and autonomous learning with validator assessments. Marsitin's research (Marsitin, 2017) also found that learning experts and mathematics education specialists approved the module, and Nieveen's classification of valid learning media has two conditions: relevance based on content validity, which means developers must understand and develop media with a material component that is up-to-date (content validity) and based on construal. Valid products meet these criteria (Nieveen, 1999:127).

Based on empirical questionnaires from validators, teachers, and students, the arithmetic e-module uses APOS theory to increase problem-solving and autonomous learning. According to Nieveen, it's practical if teachers (and other experts or validators) find the media usable and easy for teachers and students to use in a way that's mostly in line with the developer's intentions (Nieveen, 1999:127). Rettnawati (2015) added that this means the medium generated is easy for teachers and students to use (Khomsiatun & Retnawati, 2015:98).

The APOS theory that is included in the arithmetic e-module is proven to be beneficial based on the findings of statistical tests that show an increase in student problem-solving abilities and independent learning after using the e-module. This is evidenced by the fact that the APOS theory is included in the arithmetic e-module. According to Nieveen(1999:127), media is considered to be effective if students have an appreciation for learning media, which leads to an increased willingness to use the media and results in the accomplishment of the desired learning objectives. Whereas for Y. L. Sukestiyarno et al. (2019:189), the effectiveness of the product was measured from the students' cognitive results on the assessment of the emergence of the ability indicators studied, student learning completeness, and increased ability studied at the beginning and end of students' use of the product. These metrics were used to compare the students' cognitive performance before and after they used the product. It is possible to draw the conclusion that the e-module that was built throughout the course of this research is of a high quality and satisfies standards that are legitimate, practical, and effective. It can be concluded that the e-module developed in this study is of high quality and meets the valid, practical, and effective requirements.

This study has limitations where the use of the resulting e-module is not accompanied by the use of learning models or syntax and e-module users do independent learning with little outside involvement. So the researchers suggest to further researchers who are interested in this research that they use the e-modules produced in this study together with suitable

models and syntax and indicators of learning outcomes so that there is integration between steps in learning, available media, and indicators of other learning outcomes. So it is possible to develop e-modules filled with APOS theory using materials other than arithmetic.

This study has limitations because field tests were carried out by researchers directly with students without teacher involvement during the process. So the researchers suggest doing further research by involving the teacher as a user in classroom learning using an appropriate model or syntax so that the e-module has the possibility of being used with more than one learning model or syntax.

Conclusion

The quality of the arithmetic e-module loaded with APOS theory to improve problem-solving skills and independent learning is determined by the values of validity, practicality, and effectiveness, which are described as follows:

- a. The arithmetic e-module filled with APOS theory to improve problem-solving skills and learning independence was validated by material experts and media experts consisting of lecturers and teachers, from which it can be concluded that the e-module is valid.
- b. The arithmetic e-module filled with APOS theory to improve problem-solving skills and learning independence was assessed for its practicality by material experts and media experts consisting of lecturers, teachers, and students who used it, from which it can be concluded that the e-module is practical.
- c. The arithmetic e-module with APOS theory to improve problem-solving abilities and independent learning was tested on students to find its effectiveness, and it was found that problem-solving abilities and students' independent learning increased after use.

References

- Arnawa, I. M., Yerizon, Nita, S., & Putra, R. T. (2019). Development of students' worksheet based on apos theory approach to improve student achievement in learning system of linear equations. *International Journal of Scientific and Technology Research*, 8(4), 287–292.
- Arnawa, I. M., Yerizon, Y., & Nita, S. (2019). Improvement Students' Level of Proof Ability in Abstract Algebra Trough APOS Theory Approach. *International Journal of Scientific and Technology Research*, 8(7), 128–131.
- Arnon, I., Cottrill, J., & Dubinsky, E. (2014). *APOS Theory*.
- Ashnam, M., Sunaryo, S., & Delina, M. (2022). Development of Problem-Based Learning E-Modules on Renewable Energy Subjects for Distance Learning. *Journal of Physics: Conference Series*, 2377(1). <https://doi.org/10.1088/1742-6596/2377/1/012081>
- Asosiasi Penyelenggara Jasa Internet Indonesia. (2018). Potret Zaman Now, Pengguna & Perilaku Internet Indonesia. In *Apjii* (Vol. 23, pp. 1–7). <https://apjii.or.id/downfile/file/BULETINAPJIIEDISI23April2018.pdf>
- Cahyana, U., Paristiowati, M., Savitri, D. A., & Hasyrin, S. N. (2017). Developing and application of mobile game based learning (M-GBL) for high school students performance in chemistry. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(10), 7037–7047. <https://doi.org/10.12973/ejmste/78728>
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- Dewi, C. A., & Mashami, R. A. (2019). The effect of chemo-entrepreneurship oriented inquiry module on improving students' creative thinking ability. *Journal of Turkish Science Education, 16*(2), 253–263. <https://doi.org/10.12973/tused.10279a>
- Hakim, A. R., Asikin, M., & Cahyono, A. N. (2021). The Development of Learning Module with Mobile Augmented Reality Based on 9E Learning Cycle to Improve Problem Solving Skills. *Unnes Journal of Mathematics Education Research, 10*(1), 1–9. <https://journal.unnes.ac.id/sju/index.php/ujmer/article/download/43930/18061>
- Hasibuan, A. M., Saragih, S., & Amry, Z. (2019). Development of Learning Devices Based on Realistic Mathematics Education to Improve Students' Spatial Ability and Motivation. *International Electronic Journal of Mathematics Education, 14*(2), 243–252. <https://doi.org/10.29333/iejme/5729>
- Hasyim, A. F., Munawar, B., & Ma'arif, M. (2021). Penggunaan Media Video Untuk Meningkatkan Pemahaman Karakteristik Arus Searah Dan Bolak-Balik Pada Peserta didik MAN 1 Pandeglang. *Jurnal Pendidikan, 9*(1), 5–24.
- Hendriana, H., Soemarmo, U., & Rohaeti, E. E. (2017). Hard Skill dan Soft Skill. In *Refika Aditama*.
- Ilmi, R., Arnawa, I. M., Yerizon, & Bakar, N. N. (2021). Development of an Android-Based for Math E-Module by using Adobe Flash Professional CS6 for Grade X Students of Senior High School. *Journal of Physics: Conference Series, 1742*(1), 0–7. <https://doi.org/10.1088/1742-6596/1742/1/012026>
- Khomsiatun, S., & Retnawati, H. (2015). Pengembangan Perangkat Pembelajaran Dengan Penemuan Terbimbing Untuk Meningkatkan Kemampuan Pemecahan Masalah. *Jurnal Riset Pendidikan Matematika, 2*(1), 92. <https://doi.org/10.21831/jrpm.v2i1.7153>
- Marsitin, R. (2017). Modul Pembelajaran Limit Dengan Teori APOS. *Journal of Chemical Information and Modeling, Vol. 5 No.(01)*, 1689–1699.
- Nieveen, N. (1999). Prototyping to Reach Product Quality. *Design Approaches and Tools in Education and Training, 125–135*. https://doi.org/10.1007/978-94-011-4255-7_10
- Permana*, I., Zuhijatiningsih, Z., & Kurniasih, S. (2021). Efektivitas E-Modul Sistem Pencernaan Berbasis Problem Solving Terhadap Kemampuan Pemecahan Masalah. *Jurnal IPA & Pembelajaran IPA, 5*(1), 36–47. <https://doi.org/10.24815/jipi.v5i1.18372>
- Plomp, J. van den A. B. B. A. E. K. N. N. T. (2013). Educational Design Research. *Educational Design Research, 1–206*. <http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ815766>
- Prabowo, A., & Sidi, P. (2010). Memahat karakter melalui pembelajaran matematika. *Proceeding of the 4th International Conference on Teacher Education; Join Conference UPI & UPSI*.
- Prayogi, S., Yuanita, L., & Wasis, L. (2018). Critical inquiry based learning: A model of learning to promote critical thinking among prospective teachers of physic. *Journal of Turkish Science Education, 15*(1), 43–56. <https://doi.org/10.12973/tused.10220a>
- Purnamasari, I., & Setiawan, W. (2019). Analisis Kemampuan Pemecahan Masalah Matematis
-

- Siswa SMP pada Materi SPLDV Ditinjau dari Kemampuan Awal Matematika. *Journal of Medives: Journal of Mathematics Education IKIP Veteran Semarang*, 3(2), 207. <https://doi.org/10.31331/medivesveteran.v3i2.771>
- Purnamasari, N., Siswanto, S., & Malik, S. (2020). E-module as an emergency-innovated learning source during the Covid-19 outbreak. *Psychology, Evaluation, and Technology in Educational Research*, 3(1), 1–8. <https://doi.org/10.33292/petier.v3i1.53>
- Rahayu, R., Nugraheni, W., & Saleh, M. (2022). Pengaruh Latihan Ladder Drill Dan Dot Drill Terhadap Kelincahan Tendangan T Di UKM Pencak Silat Tapak Suci Universitas Muhammadiyah Sukabumi The Effect Of Ladder Drill And Dot Drill Training On T-Kick Agility In The Ukm Pencak Silat Tapak Suci Muhammadiyah. *Riyadhoh Jurnal Pendidikan Olahraga, Vol 5. No, 89–97*.
- Ramadanti, F., Mutaqin, A., & Hendrayana, A. (2021). Pengembangan E-Modul Matematika Berbasis PBL (Problem Based Learning) pada Materi Penyajian Data untuk Siswa SMP. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(3), 2733–2745. <https://doi.org/10.31004/cendekia.v5i3.759>
- Rasyid, M., Azis, A., & Saleh, A. (2016). Pengembangan Media Pembelajaran Berbasis Multimedia Dalam Konsep Sistem Indera Pada Siswa Kelas Xi Sma. *Jurnal Pendidikan Biologi*, 7(2), 69–80. <http://journal2.um.ac.id/index.php/jpb/article/view/722>
- Sukestiyarno, Y. L., Fitriyanti, N. L., & Dwidayati, N. K. (2019). The Development of Module Containing Local Culture with Realistic Approach for Mathematical Literation of Elementary School Students. *Journal of Primary Education*, 10(2), 181–191. <https://journal.unnes.ac.id/sju/index.php/jpe/article/view/34397>
- Usta, N., & Yilmaz, M. (2020). Impact of the KWL reading strategy on mathematical problem-solving achievement of primary school 4th graders. *Journal of Educational Research*, 113(5), 343–363. <https://doi.org/10.1080/00220671.2020.1830017>
- Uzel, L., & Bilici, S. C. (2022). Engineering Design-based Activities: Investigation of Middle School Students' Problem-Solving and Design Skills. *Journal of Turkish Science Education*, 19(1), 163–179. <https://doi.org/10.36681/tused.2022.116>
- Widi Priyonggo, H., & Sri Noor Asih, T. (2021). Mathematics Literacy Skill on Problem Based Learning Assisted by E-Module Agito Based on Learning Motivation. *Unnes Journal of Mathematics Education Research*, 10(1), 2021–2055. <http://journal.unnes.ac.id/sju/index.php/ujmer>
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