

Development of an Exe-Learning-based Mathematics E-module on Sequences and Series

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DOI: 10.18326/hipotenusa.v5i1.9023

Article submitted : 05 April 2023

Article accepted : 29 May 2023

Article published : 04 June 2023

Abstract

This study aims to produce Exe-Learning-based mathematics e-modules on sequences and series material for grade XI Vocational High School (SMK) that are valid, effective, and practical. This research is development research (R&D) with the ADDIE development model. The research subjects were math teachers and class XI students at SMK Putra Jaya Centre. The research instruments were expert assessment sheets, posttest questions, and teacher and student response assessment sheets. Based on the results, the e-module is categorized as very valid with an average score for content eligibility was 3.41, presentation feasibility was 3.60 and language was 3.50. Furthermore, the assessment of media experts obtained an average score on the aspect of graphic feasibility of 3.61 and media feasibility of 3.50. Testing the effectiveness of the e-module based on the results of the students' posttest obtained classical completeness results of 91% in the very effective category, while the teacher and student response questionnaire for the practicality of the e-module was 90% and 88% in the practical category. Thus, the Exe-Learning-based mathematics e-module on sequences and series material for grade XI Vocational High School students that has been developed is declared valid, effective, and practical.

Keywords: ADDIE, e-module, exe-learning

INTRODUCTION

The development of science and technology in the field of education is utilized as developing teaching materials in the form of learning support media such as videos, animations, and images. Because the object of learning mathematics is abstract, middle



and high school students need media, even though according to Piaget, junior-high school aged children (11-15 years) are already in the formal operational stage. This is because the distribution of ages at each stage of mental development still varies greatly (Istiqlal, 2017). The use of learning media that is appropriate to the material can make effective the process of delivering material to students (Nasrulloh et al., 2020). Students need variations in mathematics learning media to create a new atmosphere in the process of learning mathematics that is effective and enjoyable as a motivation for students to take part in the learning process of mathematics (Kurniawati & Azka, 2022). With the existence of learning media, students will be more interested and motivated to learn, so it will be easier to understand the material. However, there are still many schools that have not maximized the use of technology in the learning process. This problem is also seen at SMK Putra Jaya Centre that based on the results of pre-research at the school, the school still has limitations in the use of learning resources, which cannot be maximally utilized to support the learning process proportionally which can affect student learning outcomes. In addition, printed books provided by the school can only be used or accessed during class hours and cannot be taken home. Whereas students' understanding of mathematics subjects is very diverse, making it difficult for students to understand and learn the material independently without supporting teaching materials.

Based on an interview with Mrs. Yelfita, one of the mathematics teachers at SMK Putra Jaya Center explained that teachers have not maximally used learning media, other than power point and prefer to teach traditionally so that the material is easier to convey. In addition, based on a questionnaire given to 44 11th grade students of SMK Putra Jaya Center, the results are shown in Figure 1.

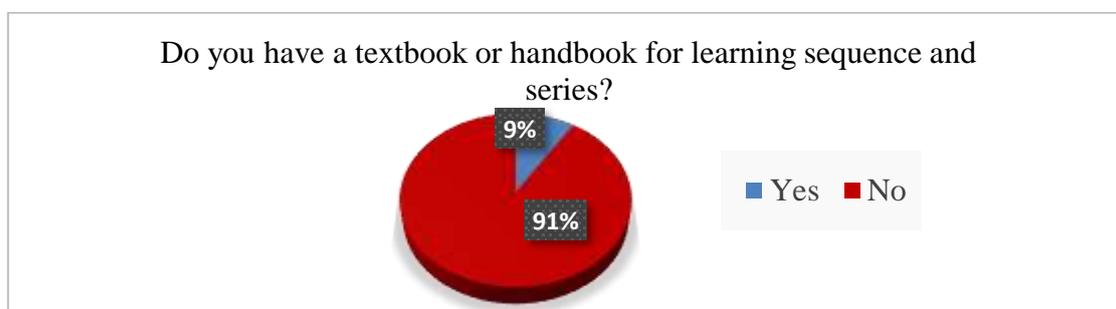


Figure 1. Diagram of Student Handbook

In Figure 1 it is obtained that the dominant students do not have a handbook that can be used to study the material of sequences and series. This also shows that the

unavailability of handbooks for students to learn mathematics results in many students scoring below the Minimum Completion Criteria (KKM), the results of the odd Semester Final Exam scores can be seen as follows.

Table 1. Mathematics Final Semester Exam Results for Class XI T.P. 2022/2023

Class	Score			Total
	$x < 70$	$70 \leq x < 80$	$80 \leq x \leq 100$	
XI Farmasi	18	0	5	23
XI KPR/TLM/TKR	12	4	5	21
Total	30	4	10	44
Percentage	68,2%	9,1%	22,7%	100%

According to (Gunawan & Ritonga, 2019), learning media is a medium for conveying messages or learning materials, so that student attention, interest, thoughts and feelings in the learning process can achieve learning goals. The learning environment consists of five parts which include: an intermediary for messages or materials in the learning process, as a learning resource, as a tool to stimulate student learning motivation, as an effective tool for achieving complete and meaningful learning outcomes, and as a tool for acquiring and improving skills (Hasan, 2021). The five components work well together which will affect learning outcomes in accordance with the expected goals. (Ramli, 2012) states that learning media can generally be divided into three major groups, namely audio media, visual media, and audio-visual media. One application of information technology in teaching is the use of electronic teaching materials such as electronic modules or e-modules. The use of E-Module can increase student motivation and learning outcomes (Kusuma et al., 2022).

E-modules are an innovation from printed modules (Handayani et al., 2021). E-modules are a set of packages containing learning materials displayed using electronic devices such as computers (laptop) or smartphones. E-modules can display text, sound, video, animation, simulations, quizzes and also images to attract students' attention in learning. (Fausih & Danang, 2015) points out that E-modules are digital or non-print learning tools that are arranged in a systematically organized manner that is used in independent learning. In other words, the e-module is an electronic version as a distance learning media that can be used anytime and anywhere using a laptop or smartphone. Therefore, E-modules still have the same character as modules (Yulia, 2021).

One of the supporting programs for developing interactive and technology-integrated e-modules is the E-Learning Xhtml Editor program. This device is computer

software whose learning implementation is displayed in web format (Hermin, 2020). Exe-Learning is an application designed to create web-based learning materials without having to master programming. In addition, Exe-Learning also provides various tools to add various animations, simulations, quizzes, practice questions with feedback and others. (Nurhalimah, 2021) revealed that Exe-Learning is a free application program that can be easily developed for online-based teaching materials. Teaching materials created with this application are organized hierarchically and systematically with topics, sections and units that facilitate independent learning by students. When making e-learning, there are three things that must be fulfilled (Andila et al., 2021), namely easy, personal and fast. Exe-Learning can present more interesting material and make it easier to learn abstract mathematics material and can display brief material, images, videos, animations, and practice questions. The goal is that the student can explore information independently and is required to be active and creative.

The material contained in this e-module is sequences and series at the Vocational High School (SMK) level. The consideration in choosing this material is because the material in mathematics lessons in which there are many collections of formulas that are useful in everyday life. Such as predicting the profits or losses that will be faced in constant business development over a period of time.

From the background problems above, the authors are interested in developing interactive media in the form of Exe-Learning-based math e-modules containing sequences and series material with various discussions and example problems, quizzes that can be known to the score and can be converted into html format, web, and applications can be used effectively and efficiently both individually and in groups.

METHODS

The method used is research and development (R&D). The development steps using ADDIE consist of analyze, design, development, implementation, and evaluation. The analysis carried out is an needs analysis, curriculum, and student characteristics analysis. At the design stage, teaching materials must be developed using Exe-Learning. At the development stage, researchers producing developed e-modules, validating by experts, and conduct initial revisions after validating. The implementation stage was carried out on a small scale trial. At the end of the meeting, students do the posttest and at a time researches distributed response questionnaires to teachers and 6 students to obtain data

related to the practicality value. Then, the evaluation is based on tests as well as teacher and student response questionnaires.

The subjects are all grade XI students of SMK Putra Jaya Cent consisting of two classes, namely XI Pharmacy as many as 23 students and KPR / TKR / TLM as many as 21 students. Instrument techniques used in data collection are validity test questionnaires, teacher and student response questionnaires, and posttest.

The e-module validity test data is obtained from questionnaire filled in by experts with a Likert scale. Exe-Learning-based math e-module developed is declared valid if the validity level for all aspects of the assessment reaches a score more than 2.8 with the valid category.

Tabel 2. Range of Scores and Categories of E-Module Validity

Score Range	Category
$\bar{x} > 3,4$	Highly valid
$2,8 < \bar{x} \leq 3,4$	Valid
$2,2 < \bar{x} \leq 2,8$	Quite valid
$1,6 < \bar{x} \leq 2,2$	Not valid enough
$\bar{x} \leq 1,6$	Not valid

The effectiveness of the e-modules using a posttest in the form of a essay. According to the provisions of the school, a student can be said to be individually complete if he achieves a minimum score of 70. Meanwhile, classical completeness is determined by calculating the percentage of students who get individual learning completeness more than 70. The criteria for the completeness of learning outcomes from the posttest results are shown in table 3. E-modules can be declared effective if student learning outcomes obtain a Minimum Completion Criteria effective category.

Table 3. Criteria for Classical Completion

Percentage (%)	Category
$p > 80$	Extremely effective
$60 < p \leq 80$	Effective
$40 < p \leq 60$	Quite effective
$20 < p \leq 40$	Less effective
$p \leq 20$	Not effective

Source: Modification of (Widoyoko, 2017)

The data obtained from the teacher and student response questionnaires for the practicality test will be analyzed and processed to obtain a percentage of the degree of achievement. This e-module can be declared practical if the results of the degree of achievement of the student and teacher questionnaires are in the practical category.

Table 4. Degree of Achievement

Percentage (%)	Category
90 - 100	Very Practical
80 - 89	Practical
65 - 79	Quite Practical
55 - 64	Less Practical
0 - 54	Not Practical

Source: Modification of (Hartanto, 2020)

RESULTS AND DISCUSSION

This research is a development research that produces a product in the form of Exe-Learning-based Mathematics E-module on Sequences and Series for Grade XI SMK. The development of the e-module follows the five stages in the ADDIE model described below.

The analysis carried out is an analysis of needs to determine the condition of teaching materials used in learning, curriculum analysis to meet the requirements of the applicable curriculum, and analysis of student characteristics in classroom learning. The needs analysis of the characteristics of students and teachers in the use of teaching materials found that 91% of students stated that they did not have a guidebook that could be used in the process of learning mathematics individually. Then, an analysis of the applicable curriculum at SMK Putra Jaya Center was carried out that this Putra Jaya Center School uses the 2013 revised curriculum 2016. As for the XI grade students of SMK Putra Jaya Center in participating in learning activities, they are less serious in the learning process. In this case, learning still uses the lecture method, making students less interested and bored. The facts in the field can be seen from the behavior of students who sometimes ignore the teacher's explanation and focus more on their cellphones or talk to friends when learning takes place. After understanding the characteristics of students, researchers are looking for alternatives to change students' activeness and bad habits when learning takes place. One of the efforts that researchers made while conducting research at the school was to hold quizzes using learning media in the form of Power Point. Researchers saw some students who were active in these learning activities. Therefore, interactive teaching materials are needed that can spur students to be active and be able to foster students' enthusiasm for learning independently or with the teacher.

At design stage, teaching materials must be developed, where teaching materials are designed using an application called exe-learning which is implemented in the form

of an offline application, web / html can be accessed using a smartphone or computer / laptop. Exe-learning program is a web-based design program designed to support and display web-based lessons and teaching materials without the need for special skills in HTML or XML (Ardliabzi in Muzijah et al., 2020; Rohmadi, 2021). At design stage, the researcher performs several steps that are used for the format of exe-learning-based math e-modules. The e-module format will be presented as follows: The initial part consists of the title, menu, cover, preface, instructions for using the e-module; The core part consists of core competencies and basic competencies, concept maps, material descriptions and evaluations. The last one is the last part consisting of a bibliography and author biographies. Here are some pictures of the initial design of the application.

Table 5. Display of Several E-Module Menus

 <p style="text-align: center;">Cover</p>	 <p style="text-align: center;">Menu</p>
 <p style="text-align: center;">Preface and instructions for using the e-module</p>	 <p style="text-align: center;">Core Competencies, Basic Competencies, and concept maps</p>



Material



Quiz



References



Author bio

At third stage, the development stage aims to see the extent of the feasibility of Exe-Learning-based math e-modules that have been designed. The activities carried out by researchers at this stage are producing the developed e-module, validating the e-module by experts, and carrying out initial revisions after validating the e-module. Validation process of all instruments using content validity, obtained the following results.

Table 6. Recap of the Results of the Instrument Content Validity

No.	Instrument	Validity Score	Category Validity
1	Post-test	1,00	Very high
2	Teacher response questionnaire	1,00	Very high
3	Student response questionnaire	1,00	Very high

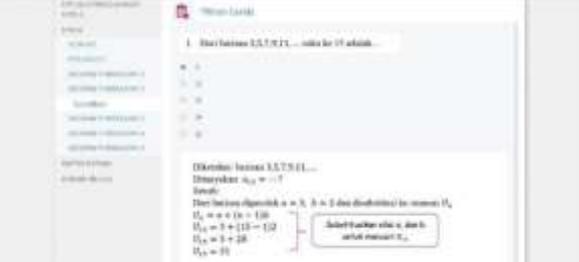
Table 7 shows the results of the validity test of Exe-Learning-based math e-modules conducted by three experts.

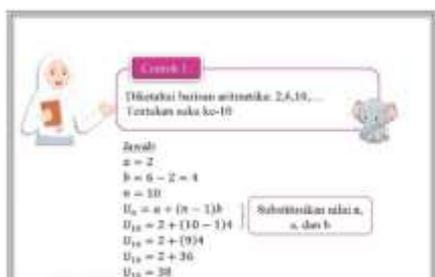
Table 7. Results of E-Module Validation by Material Experts and Media Experts

No	Expert	Aspect	Average Aspect Score	Category
1	Material	Content Eligibility	3,41	Very valid
		Eligibility of Presentation language	3,60	Very valid
			3,50	Very valid
2	Media	Graphic Eligibility	3,61	Very valid
		Media Eligibility	3,50	Very valid

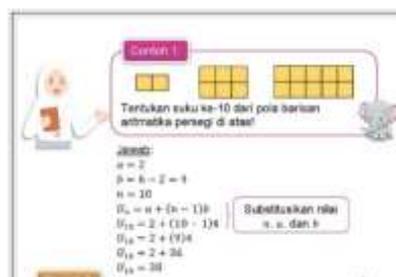
Based on the suggestions, the developed Exe-Learning-based math e-module is ready to be tested with an average score of more than 3,40 which is included in the very valid category. The e-module was declared very valid in terms of material because it met the criteria for effective and efficient e-modules, namely the subject matter in the e-module is presented coherently and includes many example problems that can help students better understand the material, and contains practice questions that can measure the level of mastery of student material and uses simple language (Vitaloka, 2021). In addition, in terms of media, it is also declared very valid because the media used has an attractive appearance, can be used easily and simply, installing applications and accessing media in web format is not difficult and does not run slowly, and has illustrations that are able to describe the material both in shape and proportional size (Hasan, 2021) as for some changes in the initial design in table 8.

Table 8. Revision of E-module

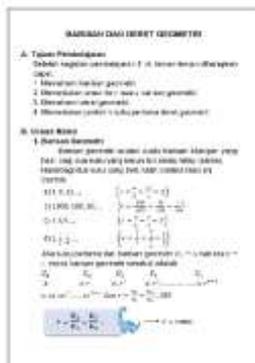
 <p>Quiz feedback before revision</p>	 <p>Quiz feedback after revision</p>
 <p>Learning objectives before revision</p>	 <p>Learning objectives after revision</p>



Sample questions before revision



Sample questions after revision



Material description before revision



Material description after revision

Table 9. Practicality Test Results

No	Aspect	Degree of Achievement	Category
1	Teacher response	90%	Very practical
2	Students response	88%	Practical

The fourth stage is the implementation. Practicality test results can be seen in table 9. Based on the practicality tests conducted, it was concluded that the math e-module is practical and can be used, because it facilitates the learning process of teachers and students, can help students understand material from sequences and series individually or in groups, uses language that is simple and easy to understand, and questions exercises and quizzes provided can help measure the level of students' knowledge of the material from sequences and series (Arsyad In Nurrita, 2018).

The fifth stage is the evaluation stage. The results of the evaluation are seen from the results of the student's post test. The number of students who took the post test were 43 students. A total of 39 students met the minimum completeness criteria with a class average of 80,98. The classical completeness proportions is $p = \frac{39}{43} \times 100\% = 91\%$. Based on table 4, because the students' classical completeness on post test was 90% -100%, the use of e-modules was categorized as very effective.

Table 10. Effectiveness Test Results

Effectiveness test	Completed	Not completed
Total student	39	4
Average score	80,98	
Classical completeness	91%	
Category	Highly Effective	

Based on the analysis carried out, the exe-learning-based mathematics e-module on sequences and series for grade XI SMK is declared valid, practical, and effective. Several previous studies have also developed exe-learning-based e-modules with similar results, namely the e-modules developed are feasible to use (Haloho, 2023; Lisyanti, 2019; Muzijah et al., 2020; Novilia, 2019; Purnomo et al., 2023; Yanti, 2022).

Advances in technology in the current era require teachers to be able to utilize technology as a means of motivating students to increase interest in learning effectively (Rahmadhani & Efronia, 2021). One of the learning media that is classified as effective and can be utilized in the teaching and learning process is e-module. This is shown by the many advantages that exist in e-modules, such as the packaging of material that is comprehensive and methodical, which includes the main components intended to achieve learning objectives. The e-module is equipped with a variety of interactive quizzes in each learning activity that helps students evaluate their understanding (Sabri, 2017). Learning mathematics using e-Modules makes students interested in participating in class learning, students are not lazy to take part in learning activities using e-modules and students are active and enthusiastic about participating in learning (Wahyudi, 2019). Also mentioned in other studies that the use of exe-learning is effective and can make it easier for students to master the material. This is because students can learn independently (Copriady, 2014) and the use of exe-learning is also known to increase student learning activities (Azizah et al., 2017). Exe-learning learning media creates a fun learning atmosphere because it can be accessed anywhere and anytime so it is practical. Practicality in learning that makes the learning atmosphere fun. A comfortable and fun learning atmosphere will make students not easily bored in learning so that it has an impact on improving student learning outcomes (Silalahi, 2020).

CONCLUSION

From the results of research and discussion of the media developed, it can be concluded that the exe-learning based mathematics e-module learning sequences and series for class XI Vocational High School students is declared valid, effective and practical. This can be seen from several test results, namely the validity test, practicality test, and effectiveness test. The validity test that was carried out by material experts and media experts showed that the developed e-module met the very valid category. The practicality test was carried out by giving student and teacher response questionnaires regarding the e-module being developed. The teacher's response is in the very practical category while the student's response is in the practical category, so that the e-module is categorized as practical. Test effectiveness by giving post-test questions to students after carrying out learning with e-modules. Based on the results of the effectiveness test, the use of e-modules is categorized as very effective. Based on the validity test, practicality test and effectiveness test, it can be concluded that the exe-based math e-module learning sequences and series for class XI Vocational High School students is appropriate for use in mathematics learning for Vocational High School students. Suggestions on the research conducted, the e-module developed can be used as a reference and can add other materials, so that the resulting product is more complete, because this product only contains sequences and series material and further development of teaching materials can add questions that are in accordance with the material and more varied.

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