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The Development of a Flipbook-Based Interactive E-Module to Facilitate Sequences and Series Learning Process for 10th Grade

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Abstract: The use of textbooks during the learning process makes it less interactive because textbooks only focus on presenting content and neglect the motivation and activities of their users. This study aims to describe the development process of a flipbook-based interactive E-module to facilitate the independent sequences and series learning process and to determine its validity, practicality, and effectiveness. The development of the E-module used the Plomp design research model, which consists of 3 phases: preliminary research, prototyping phase, and assessment phase. The quality of the developed E-module refers to valid, practical, and effective criteria. The results of this study are 1) in the preliminary research, an analysis of needs and problems, a review of the literature, and create a conceptual framework were conducted; 2) in the prototyping phase, designing and developing the E-module using Flip PDF Professional software and testing the validity of the content and media were conducted, the content validity test scored 97.33% (very valid), the construct (media) validity test scored 91.16% (very valid); 3) in the assessment phase, practicality and effectiveness tests were conducted for 1 class of 10th-grade students, the practicality test scored 78.04% (practical), and the effectiveness test got an average N-gain score of 0.7 (high level of effectiveness). Thus, the developed E-module has valid, practical, and effective criteria to facilitate independent sequences and series learning processes.

INTRODUCTION

The learning process involves interaction and communication between teachers and students (Arnila et al., 2021). The learning process plays a role in determining student learning success, so teachers must pay attention to the quality of the learning process. One factor that influences the quality of the learning process is the use of teaching content. Appropriate teaching content can build effective communication between teachers and students to achieve interactive learning. However, teachers often only use textbooks during the learning process. Arnila and Purwaningsih (2021) explained that textbooks only focus on presenting content and neglect the motivation and activities of their users. The use of textbooks makes the learning process less interactive and less motivating for students to study independently, so teaching contents are needed to support the learning process to be more interactive and motivate students to study independently.

In the current digital era, integrating technology into the learning process positively impacts the quality of learning. It makes the learning process more practical and effective in increasing students' knowledge and skills (Ramadhani and Fitri, 2021). One of the integration technology in the learning process is using E-modules. Sugianto et al. (2013) explained that E-module or electronic module presents independent teaching contents

arranged into the smallest systematic units to achieve specific learning objectives. The contents are delivered electronically, making users more active during learning. Using E-modules may support learning to be more interactive because it allows creators to provide the content in text, images, audio, videos, animations, and quizzes that students can explore (Imansari and Sunaryantiningsih, 2017).

One software that can be used to develop E-modules is Flip PDF Professional. The software allows users to convert the appearance of a textbook into an electronic book. Flip PDF Professional is a software for converting PDF files into pages that can be flipped and inserted with videos, audio, animations, and quizzes that could make the display more varied and interactive (Komikesari et al., 2020). The output of Flip PDF Professional is HTML, EXE, and APP files that allow users to upload to the website to be accessed online or used offline on a computer or mobile phone. The ease of using the E-module helps students to learn anywhere and anytime.

According to the Indonesian Dictionary, interactive means taking action. E-modules can be interactive if users can take action in the form of responding to the contents presented in E-modules, such as playing videos, answering quizzes, and getting feedback. Flipbook grammatically means flipping book (Rusli, 2019). Flipbook or flipping books at this time can be done digitally, just like opening pages in textbooks (Lamaday, 2020). Therefore, it can be concluded that flipbook-based interactive E-modules are independent teaching content presented in text, images, audio, video, and quizzes, arranged systematically and electronically, allowing users to flip the pages and respond to the contents.

Sequences and series were chosen in the E-module development because the problems in this topic are not too complex, like trigonometry, integral, etc., so students are expected to learn independently. However, the student's results on this topic are still low. According to the interview results with mathematics teachers in 10th grade, it's said that "students are confused with the use of the formula in this topic." This statement is supported by the research conducted by Nurhandayani et al. (2022), which states, "Students have difficulties applying sequences and series formulas to solve daily life problems." Therefore, this study aims to develop a flipbook-based interactive E-module to facilitate sequences and series learning processes to be more interactive, can be carried out independently, integrated with technology, and equipped with the application of sequences and series material in daily life.

This research is relevant to research conducted by Yanti and Ratu (2021) entitled "Developing Android-Based EDUTRI (E-Module Trigonometry) For Grade X Students." Yanti and Ratu developed an E-module using the ADDIE development model on trigonometry with Android-based. Another relevant research was conducted by Komikesari et al. (2020) entitled "Develop E-module Using Flip Pdf Professional on Temperature and Heat Materials." Komekasari et al. developed E-modules with the Borg and Gall development model on temperature and heat materials using Flip PDF Professional software. In comparison, the research conducted by the researcher is to develop the E-module using the Plomp design research model on sequences and series content with Flip PDF Professional software.

METHOD

This study uses the educational design research model by Plomp (2010). The detail of each phase are: (1) Preliminary research includes needs and contents analysis, literature review, and conceptual framework development; (2) Prototyping phase: aims to design the solutions at preliminary research. The prototyping phase consists of iterations cycles in designing and developing the E-module and formative evaluation. In formative evaluation, researchers use validity tests to measure the validity of content and E-module. Whether the e-module content follows scientific knowledge (content validity) and whether the e-module can be used to facilitate independent sequences and series learning processes (construct validity); (3) The assessment phase is a semi-summative evaluation to conclude whether the solution or intervention meets the pre-determined specification. The researcher uses an effectiveness test to measure whether the developed E-module can facilitate independent sequences and series learning processes. The researcher also conducted a practicality test to determine whether students experience difficulties using the E-module (Plomp and Nieveen, 2010).

Due to limited research time, the test subjects used in this study were one class of 10th-grade students who had studied sequences and series but still received pretest scores below the minimum completeness criteria (75). The research instruments used in this study are:

1. The validity sheets are used to measure the validity of the E-module. There are two validators to measure the validity: content and media experts. The media experts can be teachers or lecturers who have taught sequences and series contents, and media experts can be teachers or lecturers who have made E-modules / taught subjects related to E-modules. The aspects of the content validity test are 1) suitability; 2) ease; 3) linguistics; 4) completeness and clarity in the sequences and series materials. Then, the aspects of construct validity are 1) appearance; 2) ease of use; 3) suitability; 4) interactivity in the developed E-module. Those aspects were adapted from Martin et al. (2019).
2. The practicality sheet is a questionnaire on students' responses while using E-module. The aspects adapted from Martin et al. (2019) are 1) attractiveness, 2) linguistics, 3) usage, 4) illustration, and 5) content.
3. The pretest and posttest sheets are used to measure the effectiveness of the given treatment through independent learning with E-modules. Pretest and posttest questions are equivalent. The pretest and posttest sheets consist of five questions with indicators 1) determine the n-th term in an arithmetic sequence, 2) determine the sum of the first n-th terms of an arithmetic series, 3) determine the n-th term in a geometric sequence, 4) determine the sum of the first n-th terms of a geometric series 5) determine the number of an infinite geometric series. Due to limited research time, the pretest sheets were given to students who had studied sequence and series material in the previous semester, and posttest sheets were given to students who got pretest scores below the minimum completeness criteria (75).

Analysis of the validity and practicality tests by giving scores with the following categories.

Table 1. Categories of Validity and Practicality Sheets

Validity Categories	Score
Very Good	5
Good	4
Neither good nor poor	3
Poor	2
Very Poor	1

Practicality Categories	Positive Response Score	Negative Response Score
Strongly Disagree (SD)	1	4
Disagree (D)	2	3
Agree (A)	3	2
Strongly Agree (SA)	4	1

(Riduwan, 2004)

Then, determine the level of validity and practicality with the formula.

$$\frac{Gained\ Score}{Maximal\ Score} \times 100\%$$ (Riduwan, 2004)

And then, the data will be interpreted based on the following criteria.

Table 2. Criteria of Validity and Practicality

Intervals	Validity Criteria	Practicality Criteria
$80\% < x \leq 100\%$	Very Valid	Very Practical
$60\% < x \leq 80\%$	Valid	Practical
$40\% < x \leq 60\%$	Quite Valid	Quite Practical
$20\% < x \leq 40\%$	Less Valid	Less Practical
$0\% \leq x \leq 20\%$	Invalid	Not Practical

(Riduwan, 2004)

The developed E-module has valid and practical criteria if it obtains a percentage value of more than 60%.

The analysis of the effectiveness test is based on the N-gain calculation on students' pretest and posttest. According to Hake (1999), N-gain or normalized gain is a measurement used to estimate the effectiveness of a treatment expressed as the ratio of the actual average gain to the maximum possible average gain. The calculation of N-gain uses the formula.

$$g_{ave} = \langle \frac{\text{Posttest Score} - Pretest\ Score}{Ideal\ Score - Pretest\ Score} \rangle$$

Information:

g_{ave} = The average of *N-gain* (Wahab et al., 2021)

The N-gain calculation results will be interpreted based on the following criteria.

Table 3. Interpretation of N-gain's Score

N-gain Score	Effectiveness Level
$(g) \geq 0.7$	High
$0.3 \leq (g) < 0.7$	Medium
$0 < (g) < 0.3$	Low
$g \leq 0$	Fail

(Wahab et al., 2021)

The E-module is effective in facilitating sequences and series learning processes if the average of N-gain reaches a medium or high level.

RESULT AND DISCUSSION

This study's results describe the E-module development process and average scores on the content and construct validity, practicality, and effectiveness test. The E-module development process will be explained in each phase of the Plomp design research.

Preliminary Research

In this phase, an analysis of needs and problems was conducted by interviewing mathematics teachers in the 10th grade. The interview results showed that.

Researcher : Do students learn through textbooks?
Teacher : No, because today's children have less reading interest in textbooks. They prefer to watch and listen to videos than read books.
Researcher : How are students' learning outcomes in sequences and series material?
Teacher : The study results are not good. But thank God they got medium scores.

The conclusion of the interview transcript is: (1) low self-learning motivation of students to read textbooks; (2) students prefer to learn through explanation videos rather than textbooks; (3) student test results on sequences and series are low. Then, the researchers reviewed the literature to support the interview results, as explained in the introduction. And the developed conceptual framework is

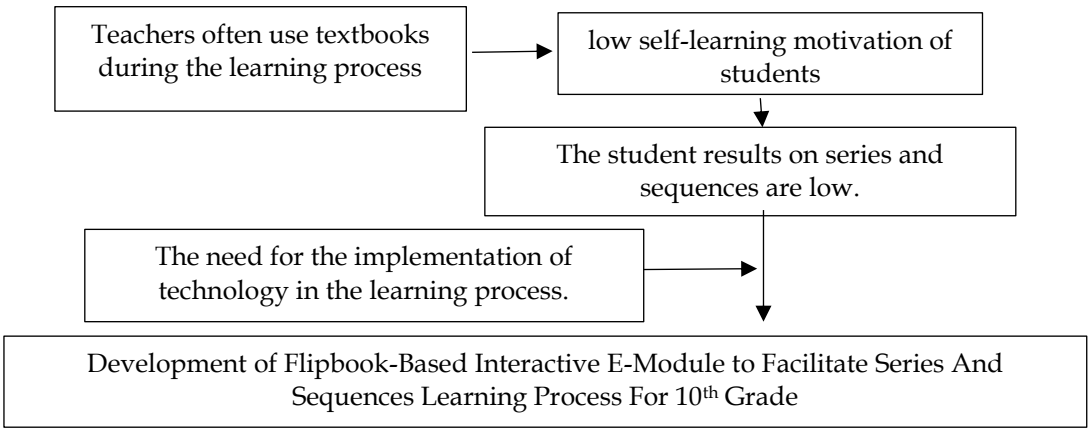
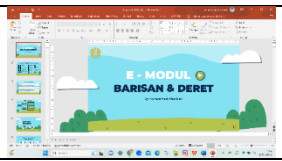


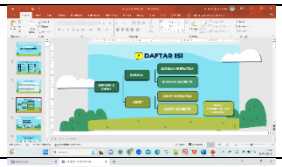
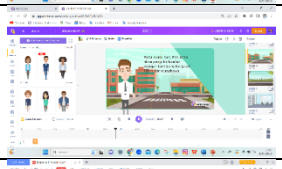
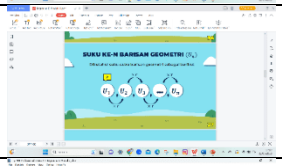
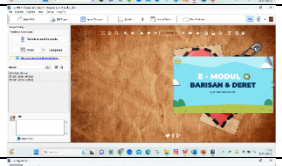
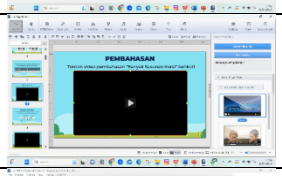
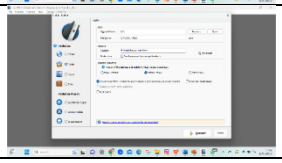
Figure 1. The Research Conceptual Framework

Prototyping Phase

At this phase, the researchers designed a solution at preliminary research by developing a flipbook-based interactive E-module to facilitate independent sequences and series learning processes. The development of a flipbook-based E-module utilizes software, namely Flip PDF Professional. The explanations of E-module development are:

Table 4. The E-module Development Process

No	Stages	Pictures
1.	Design the appearance of the E-module using *PowerPoint.*	

No	Stages	Pictures
2.	Determine the content of the E-module.	
3.	Make videos about sequences and series problems.	
4.	Convert the PowerPoint into a PDF file.	
5.	Convert a PDF file into E-module with Flip PDF Professional.	
6.	Input videos and quizzes on the E-module.	
7.	Save the E-module into EXE and HTML.	
8.	The E-module at this stage is called prototype-1	http://unesa.me/6jye79

The next step is to test the validity of prototype-1. There are two validity tests: content and construct (media) validity tests. The results of the content and construct validity test will be analyzed. Based on the results of the content and construct validity test, it is obtained as follows.

Table 5. The Content Validity Result

Aspects	Content Expert Score	
	I	II
Suitability		
The suitability of contents with learning objectives.	5	5
The suitability of exercises with learning objectives.	5	5
The suitability of problems with contents.	5	5
The suitability of content selection with independent learning.	5	5
Ease		
The images help to understand the contents.	5	5
The videos help to understand the contents.	5	5
The problems help to understand the contents.	5	5
The exercises help to understand the contents.	5	5
The given solution helps to understand the contents.	5	5
Completeness and Clarity		
The regularity of the contents.	5	5
The completeness of the contents.	5	5

Aspects	Content Expert Score	
	I	II
The clarity of contents.	5	4
Linguistic		
The contents are written using the correct Indonesian language rules.	4	4
The contents are written using the correct punctuation.	4	5
The use of words that is not ambiguous in the E-module.	5	5
Gained Score	73	73
Maximal Score	75	75
Content Validity Level (%)	**97.33**	**97.33**

Table 6. The Construct Validity Result

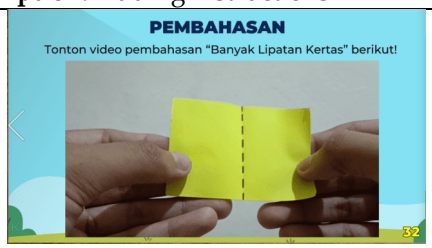
Aspects	Media Experts Score	
	I	III
Appearance		
The accuracy of choosing the font size.	4	4
The accuracy of choosing the font types.	4	5
The accuracy of choosing the spacing size.	5	4
The accuracy of choosing the color.	5	5
The accuracy of arranging the display.	5	4
The clarity of the illustrated images.	5	4
Video clarity on the E-module.	5	5
Audio clarity on the E-module.	4	5
Ease of use		
Ease of use of the E-module.	5	4
Clarity of instructions for using the E-module	5	4
Using the E-module does not require an additional application.	5	4
Suitability		
The suitability of selecting the E-module as an independent teaching content on the sequences and series.	5	4
The suitability of the E-module with the development of science.	5	4
The suitability of the E-module with technological developments.	5	4
Interactivity		
The attractiveness of the illustrated images presented in the E-module.	5	4
The attractiveness of the videos presented in the E-module.	5	4
The attractiveness of the E-module display.	5	5
The exercises and quizzes presented in the E-module allow users to interact and get feedback.	5	4
Gained Score	87	77
Maximum score	90	90
Media Validity Level (%)	**96.67**	**85.56**

The content validity test scored 97.33% by the two validators. According to Tabel 2, the score has a **very valid** criterion. The score indicates that the contents in the E-module are very valid with scientific knowledge. The construct validity scored 85.56% and 96.67%, with an average score of 91.15%. According to Tabel 2., The score has a **very valid** criterion for facilitating the independent learning process of sequences and series. The content and

construct validity test scores indicate that the developed E-module can be used in the assessment phase with small revision.

Revisions on the E-module were based on the validator's suggestions. Some of the revisions that researchers have done are.

Table 7. Before and After Revision

Before Revision	After Revision
	
Description: No instructions	**Description:** Adding instructions
	
Description: The appearance of the video before the revision.	**Description:** The appearance of the revised video.

The results of the prototype-1 revision called prototype-2, will be tested (practicality tests and effectiveness tests) on twenty-seven students. The results of the test will be described in the assessment phase.

Assessment Phase

At this phase, the practicality and effectiveness tests were conducted on prototype-2. The results of the practicality test are

Table 8. The Practicality Test Result

Response Type	Aspects	Amount				Score
		SD	D	A	SA	
Positive	The Attractivity of the Display.	0	0	16	11	92
	The E-module contains clear navigation.	0	1	20	6	86
	Audio can be heard clearly.	0	2	24	1	80
	Images can be seen clearly.	0	0	17	10	91
	The illustrations help to understand the content.	0	1	20	6	86
	Exercises help to understand the content.	0	2	19	6	85
	The E-module is easy to use anywhere.	0	2	18	7	86
Negative	E-module is difficult to operate.	5	17	5	0	81
	The content is difficult to understand.	2	21	2	2	77
	The language is difficult to understand.	4	20	3	0	82
	The video cannot be seen clearly.	6	17	4	0	83
	The video help to understand the content.	6	19	1	1	84
	The content is not related to daily life problems..	3	21	3	0	81
	The E-module is not easy to use at any time.	8	16	3	0	86
Gained Score						1180
Maximum Score						1512
Practicality Level (%)						**78.04**

The practicality test conducted on 27 students scored 77.84%. According to Table 2, the score indicates that the developed E-module has **practical** criterion. The score indicates that the developed E-module is easy to use, or students have no difficulty while using the E-module. Then, the result of the effectiveness test is

Tabel 9. The Effectiveness Test Result

Subjects	Score			*N-gain*	Criteria
	Pre	*Post*	Ideal		
AAG	8	55	100	0.5	Medium
AAP	10	40	100	0.3	Medium
ARA	18	95	100	0.9	High
APR	16	100	100	1.0	High
FAS	33	55	100	0.3	Medium
HIA	6	30	100	0.3	Medium
IRA	33	100	100	1.0	High
KBA	18	100	100	1.0	High
LFI	5	20	100	0.2	Low
MRA	6	55	100	0.5	Low
MBZ	23	50	100	0.4	Medium
MFZ	3	65	100	0.6	Medium
MFA	15	60	100	0.5	Medium
MRM	23	70	100	0.6	Medium
MRF	0	25	100	0.3	Medium
QAI	53	100	100	1.0	High
RA	50	85	100	0.7	High
SNA	50	75	100	0.5	Medium
SMM	43	100	100	1.0	High
SPM	50	85	100	0.7	High
SB	50	85	100	0.7	High
SFA	38	100	100	1.0	High
VAM1	55	85	100	0.7	High
VAM2	10	100	100	1.0	High
WLD	23	100	100	1.0	High
ZNH	5	25	100	0.2	Low
ZMA	15	75	100	0.7	High
g_{ave} *(Average of N-gain)*				0.7	High

The effectiveness test scored 0.7. According to Table 3, the score indicates that the flipbook-based interactive E-module has **High** level of effectiveness. The results of the effectiveness test can be seen that students get better posttest scores than pretest. So giving treatment in the form of independent learning with E-modules is highly effective in facilitating independent sequences and series learning processes.

According to the development process of the E-module, there are several notes from researchers as follows. First, there are several functional limitations on Flip PDF Professional that researchers faced, namely: (1) There is no feature to input answers. However, researchers are trying to find alternative solutions by creating buttons containing options for the answer, allowing users to click answers and get feedback;

Figure 2. Exercices on the E-module

(2) There is no feature to limit page movement; students can open the content randomly and neglect content orders. However, researchers try to provide instructions through self-assessment, which requires students to obtain a minimum score to proceed to the following content;

Figure 3. Quizzes on the E-module

(3) There is no feature to randomize questions and answers, so the quizzes are unsuitable as a test. Therefore, the exercises and quizzes on the E-module are more suitable for exercises; (4) The software does not allow the maker to see the quiz scores obtained by students. However, creators can make quizzes with websites like Google Forms, Quizzis, etc.

Second, the students' pretest results show that students are unable to apply formulas to solve sequences and series problems. One of the student results is.

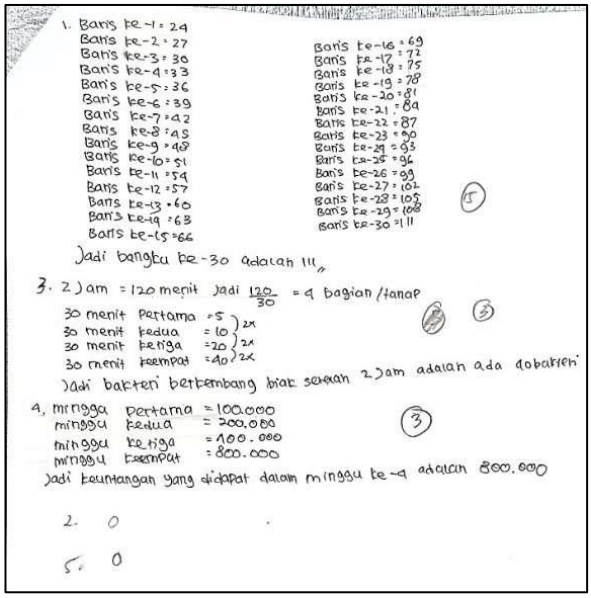


Figure 4. Students' pretest result

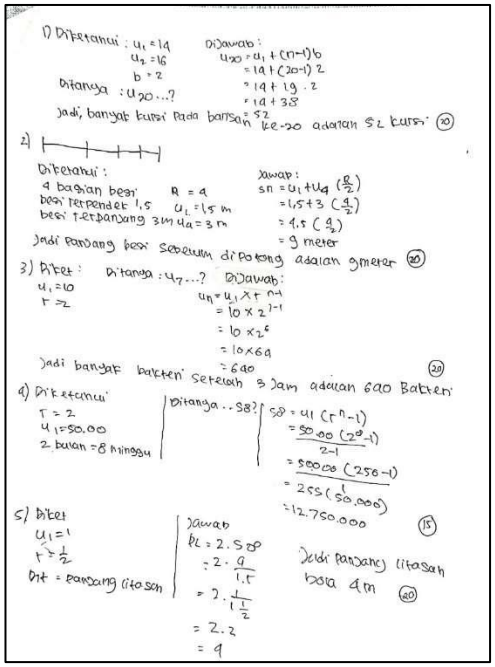


Figure 5. Students' posttest result

In number 1, students are asked to determine the number of seats in the 30th row; the difference on each row is 3. The result shows that students succeeded in answering the questions by listing the number of seats. However, students cannot apply the nth-term

formula to the arithmetic sequence. The inability of students to apply formulas also appears in numbers 2-5. However, significant posttest results were obtained by giving treatment in the form of independent learning with flipbook-based interactive E-module on sequences and series. The posttest result shows that students can apply formulas to solve the problems. Thus, the results of the N-gain score correctly indicate that the treatment with E-modules has a **high** level of effectiveness. This statement was supported by the research conducted by Lisyanti (2019); the E-modules are effectively used as teaching content. And according to Sembiring et al. (2021), Asrial et al. (2020), Sunismi and Fathani (2016): the E-module increases students' learning outcomes. So the developed E-module can be used as teaching content to facilitate independent sequences and series learning processes.

Third, using E-modules to facilitate independent learning of sequences and series still requires teacher explanations. This statement is based on a message from a student.

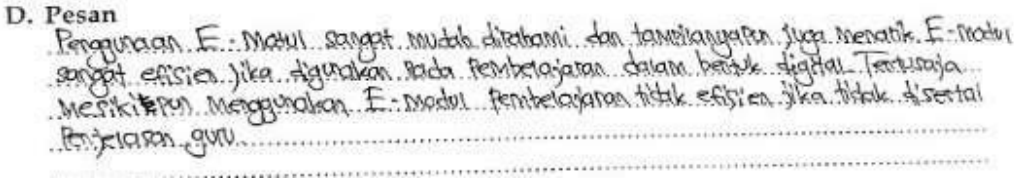


Figure 6. A message from a student

"Using the E-module is easy to understand, and the appearance is attractive. E-modules are very efficient when used in digital learning. Of course, even using the E-module, learning is inefficient if a teacher does not explain the content." Therefore, the use of the E-module will be maximized if the teacher continues to explain the content, and students can use the E-module as a supplement for independent learning anywhere and anytime. This statement was supported by the research conducted by Safaati et al. (2022) that said, "E-module can be used as a learning supplement." So the Developed E-module can be used as a learning supplement to help students study independently.

Fourth, the student pretest results were still below the Minimum Completeness Criteria (75). The results of the students' pretest indicated that they forgot about the sequences and series content they had in the previous semester. This statement is supported by a message from a student.

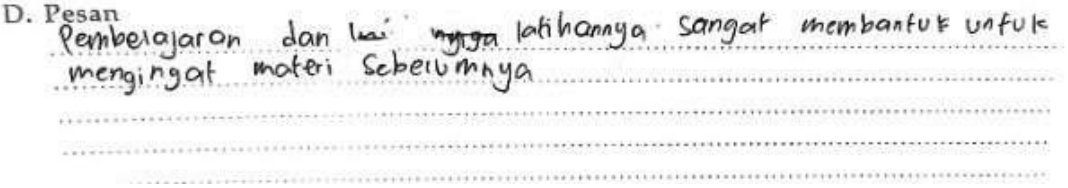


Figure 7. A message from a student

"These learning and practice are beneficial to remember the previous topic." Therefore, using E-modules can be a learning supplement for students to study independently. The use of E-modules can help students to recall the previous topic. This statement was supported by Khotimah et al. (2022) research that said, "the E-module helps students to study

independently." That means students can use the E-module to study the previous content independently.

The E-module can be used as teaching content to facilitate independent sequences and series learning or as a learning supplement for students to study independently. But, the use of the E-module will be maximized if the teacher still provides explanation and use E-module as a supplement to independent learning anywhere and anytime.

CONCLUSION AND SUGGESTIONS

Based on the design research result conducted by the researchers, it can be concluded that the development process of a flipbook-based interactive E-modules on sequences and series for 10th grade using the Plomp design research model consists of 3 phases: preliminary research, prototyping phase, and assessment phase. In the preliminary research, an analysis of needs and problems, a review of the literature, and create a conceptual framework were conducted. In the prototyping phase, designing and developing the E-module using Flip PDF Professional software and testing the validity of the content and media were conducted. In the assessment phase, practicality and effectiveness tests were conducted for 1 class of 10th-grade students. The content validity test scored 97.33% (**very valid)**. The media validity test scored 91.16% (**very valid)** for facilitating the sequences and series learning processes. The practicality test scored 78,04% (**practical**). The effectiveness test scored 0.7 (**high)**. So, the developed E-module has valid, practical, and effective in facilitating independent learning of sequences and series.

A suggestion for teachers who want to use the E-module to facilitate independent learning, it is hoped that the teacher still provides explanations on the E-module because the use of the E-module will be maximized if it is used as a supplement to independent learning anywhere and anytime. Then, a suggestion for readers who want to do the same research, it is expected that the subject is students who have not studied the content in the developed E-module to get clear results on whether students get increased learning outcomes through the E-module or not.

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