



DEVELOPMENT OF AN ONLINE LEARNING MODULE FOR SYSTEMS OF LINEAR EQUATIONS IN TWO VARIABLES (SPLDV) ASSISTED BY THE DESMOS WEB PLATFORM

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Abstract

This is a research and development (R&D) that produce a learning module, on the topic of SPLDV in class VIII at SMP Negeri 1 Remboken. The module was developed by using the ADDIE method. We obtain that the learning module satisfies the criteria of validity, effectiveness and practicality. The results of the learning module validity from the experts of the topics is 4.56 and from media experts is 4.48. This satisfy the very valid category. By using the modul we obtained the average student learning outcomes test is 80.45 with a percentage of completeness of 90.91%, which is a very effective category. Teacher's assessment of the module is 4.27 which is a very practical category, and the students respons is very positive category. By this, we conclude that by using the learning module on the SPLDV topic for class VIII students at SMP Negeri 1 Remboken, students readiness and understanding in the learning process can develop well.

Keywords: ADDIE, Desmos Web, Learning Module, R&D

INTRODUCTION

Mathematics is a logical discipline that encompasses “form, structure, magnitude, and concepts related to one another,” which are generally divided into three principal fields: algebra, analysis, and geometry [1]. Mathematics plays a crucial role in the advancement of scientific knowledge and the development of human resources [2]. As a compulsory subject across all levels of education,

mathematics should enhance students' cognitive abilities and equip them with logical reasoning and problem-solving skills [3]. Based on the results of international assessments such as PISA and TIMSS, as well as the National Examination (UN) results from 2006 to 2024, the average scores remain significantly below the OECD average score of 500 [4].

The results of interviews with mathematics teachers at SMP Negeri 1



Remboken revealed a decline in students' academic achievement, particularly in the topic of Systems of Linear Equations in Two Variables (SPLDV). Out of 100 students, only 35% achieved the Minimum Mastery Criteria (KKM = 75), while 65% had not yet understood the fundamental concepts of linear equations in two variables. To date, the dominant instructional approach has been conventional, where the teacher serves as the primary source of information, while students mainly listen, take notes, and memorize concepts. In fact, the school already possesses supporting facilities such as LCD projectors and a computer laboratory. The COVID-19 pandemic forced the learning process to shift to an online format, thereby presenting new challenges for both teachers and students in delivering mathematics material that is engaging and easily understood in a virtual environment [5].

As a response, self-directed learning modules have become one potential solution. To achieve satisfactory learning outcomes, teachers are required to prepare appropriate instructional materials and learning tools [6]. A module is not merely a supporting learning aid, but also an important instrument for developing learning that is more open and adaptable to change [7]. However, printed modules alone are insufficient without interactive supporting media [8].

Desmos Graphing Calculator has emerged as an alternative web-based learning medium. This application enables the instant generation of equation graphs, featuring 2D plotting, animated sliders, and a student-friendly

interface [9]. Teachers can create virtual classrooms in Desmos, assign tasks, and monitor students' progress. Students can also save and share their graphs at any time without additional cost, requiring only an internet connection.

Referring to the problems described above, this study was conducted to develop a learning module assisted by the Desmos Web that is valid, effective, and practical.

METHOD

This study is a Development and Research study conducted at SMP Negeri 1 Remboken in the mathematics subject on the topic of Systems of Linear Equations in Two Variables (SPLDV) for Grade VIII in the first semester of the 2022/2023 academic year. The development model employed in this study is ADDIE (Analysis, Design, Development, Implementation, Evaluation).

The instruments used in this study consisted of observation sheets, interviews, and research questionnaires. The media evaluation questionnaire was designed using four alternative response options, while the student response questionnaire employed five alternative response options.

The development of the learning media is considered successful if it meets the criteria of validity, practicality, and effectiveness. The validity criterion is determined based on the results of the media evaluation questionnaire administered to media experts, subject-matter experts, and mathematics teachers. The practicality criterion is assessed through the results of the pilot test media evaluation questionnaire and the corresponding

responses. The effectiveness criterion is determined based on students' learning outcomes and the student response questionnaire.

The data obtained from the media evaluation questionnaires completed by teachers, subject-matter experts, and media experts were

subsequently analyzed. The data from the student questionnaires and the media evaluations by teachers, subject-matter experts, and media experts were initially in letter form and were then converted into numerical values according to the following criteria:

Table 1. Assessment Scores

Category	Score
Excellent (E)	4
Good (G)	3
Fair (F)	2
Poor (P)	1

RESULTS AND DISCUSSION

This study was conducted at SMP Negeri 1 Remboken during the second week of October 2022. Prior to the implementation of the study, the researcher conducted observations to examine the situation and conditions at the school, followed by consultations with the supervisor. The research instruments, consisting of the learning module and test items, were validated by a mathematics lecturer from Universitas Negeri Manado and a mathematics teacher from SMP Negeri 1 Remboken before use. The results of this validation are as follows.

Analysis

The analysis stage is the first phase in development research, and the results of this analysis serve as a reference for the development of the learning media product. In this stage, the researcher contacted SMP Negeri 1 Remboken to conduct three procedures: curriculum analysis, student needs analysis, and learning analysis.

Design

The next stage is design. In this stage, the researcher began designing the learning module to be developed.

a. Compilation of the Learning Module Framework

The framework of the developed module is based on the Grade VIII mathematics syllabus. The module consists of three main sections: the beginning, the content, and the ending. The beginning section includes the cover, module identity, initial competencies, Pancasila student profile, facilities and infrastructure, target learners, and learning model. The content section comprises learning objectives, meaningful understanding, guiding questions, learning activities, assessment, and enrichment. The ending section contains student worksheets (LKPD), reading materials for teachers and students, a glossary, and a reference list.

b. Design and Feature Development of the Learning Module

In this section, the design and features of the learning module encompass the beginning, content, and

ending sections. The learning module design is as follows:

1) Beginning Section

In the beginning section, the design of the SPLDV learning module cover includes the front cover displaying the title of the instructional material, namely Mathematics Learning Module on the topic of

SPLDV using the Desmos Web, along with the researcher's name as the module developer.

2) Content Section

Next, the content section of the module, which includes the key aspects of the module, is presented in the figure.

KOMPONEN INTI	
A. TUJUAN PEMBELAJARAN	▪ Dapat mengotati persamaan linear dua variabel dan arti penyelesaiannya. ▪ Dapat mengenali sistem persamaan linear dua variabel dan arti penyelesaiannya. ▪ Dapat menjelaskan prinsip-prinsip untuk menyelesaikan sistem persamaan, yaitu dari 2 buah persamaan linear 2 variabel mengarah pada persamaan linear 1 variabel. ▪ Dapat menyelesaikan sistem persamaan dengan menggunakan metode penambahan dan pengurangan atau metode substitusi. ▪ Dapat menyelesaikan sistem persamaan yang agak kompleks, misalnya yang memuat tanda kurang, pecahan, koefisiennya berupa pecahan, dan lain-lain.
B. PEMAHAMAN BERMAKNA	Mengajarkan arti dari istilah persamaan linear dua variabel serta arti persamaan linear satu variabel. Selain itu, peserta didik mengonfirmasi arti penyelesaian persamaan, serta peserta didik diberi pemahaman bahwa penyelesaian persamaan linear 1 variabel adalah tunggal (1 solusi), sedangkan penyelesaian persamaan linear 2 variabel belum tentu 1 buah atau tunggal. Pada pertanyaan 1, diharapkan peserta didik dapat memahami bahwa penyelesaian persamaan linear dua variabel $2x + y = 11$ dibatasi 6 himpunan penyelesaian saja, tetapi jika daerah asal x dan y adalah seluruh bilangan real maka penyelesaiannya ada tak hingga banyaknya solusi (tidak terhingga).
C. PERTANYAAN PEMANTIK	▪ Menanyakan kepada peserta didik tentang persamaan linear dua variabel dan arti penyelesaiannya. ▪ Menanyakan kepada peserta didik tentang sistem persamaan linear dua variabel dan arti penyelesaiannya. ▪ Menanyakan kepada peserta didik tentang prinsip-prinsip untuk menyelesaikan sistem persamaan, yaitu dari 2 buah persamaan linear 2 variabel mengarah pada persamaan linear 1 variabel. ▪ Menanyakan kepada peserta didik tentang cara menyelesaikan sistem persamaan dengan menggunakan metode penambahan dan pengurangan atau metode substitusi. ▪ Menanyakan kepada peserta didik tentang cara menyelesaikan sistem persamaan yang agak kompleks, misalnya yang memuat tanda kurang, pecahan, koefisiennya berupa pecahan, dan lain-lain.
D. KEGIATAN PEMBELAJARAN	PERTEMUAN KE-1 SISTEM PERSAMAAN DAN PENYELESAIANNYA Kegiatan Pendahuluan (10 Menit) ▪ Doa, absensi, menyampaikan tujuan pembelajaran, dan menyampaikan penilaian hasil pembelajaran ▪ Memotivasi siswa untuk tercapainya kompetensi dan karakter yang sesuai dengan <i>Profil Pelajar Pancasila</i>; yaitu 1) beriman, bertakwa kepada Tuhan Yang Maha Esa, dan berakhlak mulia, 2) mandiri, 3) bermalar kritis, 4) kreatif, 5) bergotong royong, dan 6) berkebinekaan global, yang merupakan salah satu kriteria standar kelulusan dalam satuan pendidikan. Kegiatan Inti (90 Menit)

- Dengan membandingkan cara seperti ini, peserta didik diharapkan dapat mengetahui keunggulan cara mengubah koefisien menjadi bilangan bulat. Pada Contoh 7, penting sekali peserta didik memahami hubungan 2 nilai yang sama seperti pada (1) dan (2) berikut ini.

$$(1) \quad A = B = C$$

$$(2) \quad \textcircled{a} \begin{cases} A = B \\ A = C \end{cases} \quad \textcircled{b} \begin{cases} A = B \\ B = C \end{cases} \quad \textcircled{c} \begin{cases} A = C \\ B = C \end{cases}$$

- Di sini, guru menekankan kembali bahwa ada tiga cara, yaitu a, b, c untuk membuat dua persamaan. Pada buku ini diberikan contoh persamaan yang diubah menjadi bentuk c, tetapi bisa juga diselesaikan dengan persamaan yang diubah ke dalam bentuk a atau b. Sebaliknya peserta didik diajak berpikir dengan membandingkan ketiganya. Soal akan dapat diselesaikan secara efisien dan penyelesaiannya akan sama meskipun kombinasinya bentuk apa pun.
- Peserta didik diminta memikirkan aplikasi matematika, khususnya pada penggunaan materi yang telah dipelajari, setelah memahami cara menyelesaikan sistem persamaan. Seperti dalam buku ucapan, contoh aplikasi terdapat di B.

Kegiatan Penutup (10 MENIT)

- Siswa dan guru menyimpulkan pembelajaran hari ini.
- Refleksi pencapaian siswa/formatif asesmen, dan refleksi guru untuk mengetahui ketercapaian proses pembelajaran dan perbaikan.
- Menginformasikan kegiatan pembelajaran yang akan dilakukan pada pertemuan berikutnya.
- Guru mengakhiri kegiatan belajar dengan memberikan pesan dan motivasi tetap semangat belajar dan diakhiri dengan berdoa.

E. ASESMEN / PENILAIAN HASIL PEMBELAJARAN

a) Penilaian Sikap / Profil Pelajar Pancasila

Selama proses mengajar berlangsung guru mengamati profil pelajar Pancasila pada siswa dalam pembelajaran yang meliputi Beriman, bertakwa kepada Tuhan Yang Maha Esa, Kebhinekaan Global, Mandiri, Bernalar Kritis, Gotong Royong dan Kreatif

b) Penilaian Pengetahuan

Penilaian pengetahuan yang dilakukan pada Capaian Pembelajaran ini sesuai dengan tujuan pembelajaran yang ingin di capai adalah dengan tes tertulis

c) Penilaian Keterampilan

Penilaian keterampilan yang dilakukan pada Capaian Pembelajaran ini sesuai dengan tujuan pembelajaran yang ingin di capai adalah dengan tes unjuk kerja / praktek

SOAL TES FORMATIF

Untuk persamaan linear dua variabel $x + y = 11$ (1) dan $x - y = 5$ (2), pilih satu jawaban benar dari (a) - (d) berikut.

(a) $\begin{cases} x = 7 \\ y = 2 \end{cases}$ (b) $\begin{cases} x = 8 \\ y = 7 \end{cases}$ (c) $\begin{cases} x = 6 \\ y = 5 \end{cases}$ (d) $\begin{cases} x = 8 \\ y = 3 \end{cases}$

(1) Apakah penyelesaian dari masing-masing persamaan (1) dan (2)?

(2) Setelah memandang (1) dan (2) sebagai sistem persamaan, apakah penyelesaiannya?

Selesaikan setiap sistem persamaan berikut.

(1) $\begin{cases} x - 3y = 4 \\ x + 3y = 10 \end{cases}$

(3) $\begin{cases} 2x - 3y = 7 \\ 3x + 2y = 4 \end{cases}$

(2) $\begin{cases} 2x + 3y = -8 \\ 4x + 3y = 12 \end{cases}$

(4) $\begin{cases} 2x + y = -9 \\ x - 3y = 4 \end{cases}$

Figure 1. Learning Objectives, Understanding, Guiding Questions, and Learning Activities

3) Ending Section

The ending section of the module can also be considered as the supplementary part of the module. Classroom evaluations are presented in the figure, in the form of student worksheets (LKPD).

Development

The next stage involves carrying out the development steps, which are as follows:

a. Learning Module Production

At this stage, the product designed in the previous phase is further developed with the aim of

producing the final product, which has been revised based on suggestions and feedback from experts.

b. Product Feasibility Validation

After the module is completed, it is analyzed and then subjected to product feasibility validation. The learning module validation is conducted by validators, consisting of subject-matter experts and media experts.

(1) Subject-Matter Expert Validation

The subject-matter experts involved in the learning module validation consisted of two individuals: a mathematics lecturer from Universitas Negeri Manado and a mathematics teacher from SMP Negeri 1 Remboken. The results of the module verification by these two validators are summarized in Table 2.

Table 2. Module Validation Results by Subject-Matter Experts

Assessment Aspect	Validator Evaluation		Aspect Average	Overall Average
	I	II		
Learning Aspect				
1. Alignment of the Material with Initial Competencies and Learning Objectives	4	4	4	4,5
2. Clarity of Learning Indicators/Objectives	4	5	4,5	
3. Sequence of Presentation	5	5	5	
Language Aspect				
4. Clarity of the Language Used	5	5	5	4,62
5. Appropriateness of the Language to the Material	4	5	4,5	
6. Clarity of the Methods Provided	5	4	4,5	
7. Alignment of the Assessment Items with the Material Presented	5	5	5	
8. Alignment of the Assessment Items with the Competencies	4	5	4,5	
9. Balance Between Assessment Items and the Material	5	4	4,5	
10. Quality of the Assessment Items Provided	4	5	4,5	
11. Appropriate Use of Spacing	5	4	4,5	
Overall Average = 4.56				

Table 2 above presents the results of the product validity study, specifically the mathematics learning module on SPLDV using the Desmos Web, as assessed by subject-matter experts. The overall score obtained from the subject-matter expert

evaluation was 4.56, indicating that the product is categorized as highly valid.

(2) Media Expert Validation

The media experts involved in the learning module validation consisted of two individuals, both of

whom are mathematics lecturers at Universitas Negeri Manado. Table 3 below presents the results of the

product validity assessment as evaluated by the media experts.

Table 3. Module Validation Results by Media Experts

Assessment Aspect	Validator Evaluation		Aspect Average	Overall Average
	I	II		
Learning Aspect				
1. Appropriateness of the Language to the Students' Cognitive Development Level	4	4	4	4,5
2. Sentences Used Are Clear and Do Not Cause Multiple Interpretations	4	5	4,5	
3. Consistency in the Use of Terms within the Module	5	5	5	
Language Aspect				
4. Appropriateness of the Paper Used	5	5	5	4,62
5. Attractiveness of the Design on Each Page	4	5	4,5	
6. Harmony of the Background Colors	5	4	4,5	
7. Readability of the Fonts Used	5	5	5	
8. Neatness of the Text Layout Used	4	5	4,5	
9. Alignment Between Text and Images	5	4	4,5	
10. Appropriate Use of Spacing	4	5	4,5	
Overall Average = 4.48				

Implementation

The next stage involves implementing the product, which has been categorized as highly valid and feasible, for classroom trial. A limited trial was conducted at SMP Negeri 1 Remboken, involving one Grade VIII mathematics teacher and 22 students,

to assess the responses of both the teacher and students, as well as the attractiveness of the learning module.

The following are the learning test results of the 22 students, along with the teacher's and students' responses to the trial of the product developed by the researcher.

Table 5. Student Test Results

No	Student	Test Score	Minimum Mastery Criteria
1	AS	90	Completed
2	AW	80	Completed
3	BM	70	Not Completed
4	CM	80	Completed
5	CR	80	Completed

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6	GS	60	Tidak tuntas
7	GB	85	Completed
8	IT	85	Completed
9	IK	80	Completed
10	JK	90	Completed
11	JN	85	Completed
12	JN	70	Not Completed
13	JN	80	Completed
14	JP	80	Completed
15	MR	85	Completed
16	MP	80	Completed
17	NP	90	Completed
18	OS	80	Completed
19	PK	85	Completed
20	PS	85	Completed
21	SE	75	Completed
22	MZ	75	Completed
Average		80.45	COMPLETED

Table 6. Teacher Response Results

No	Criteria	Score
1	Cover Page Design of the SPLDV Learning Module	5
2	The selection of font type, size, and spacing is appropriate, facilitating students' ease of reading the SPLDV learning module.	4
3	The flat-faced solid geometry module facilitates learning in the SPLDV mathematics course.	5
4	The SPLDV learning module uses simple and easily understandable sentences for students.	5
5	The Sequence of Content in the SPLDV Learning Module	4
6	The material presented in the flat-faced solid geometry module helps students achieve the learning objectives in accordance with the basic competencies.	5
7	The presentation of the material in the module does not create ambiguous or multiple interpretations for students.	5
8	The use of the module can encourage students to participate more actively in learning activities.	5
9	The SPLDV learning module encourages students to engage in discussions with their peers.	5
10	The SPLDV learning module assists students in discovering the concepts of the material.	4
11	The sequence of material presentation in the module aligns with the intended learning indicators.	4
Overall Average		4,27

Table 7. Student Response Results

No	Criteria	Response Scale Alternatives					Positive Response Percentage	Description
		5	4	3	2	1		
1	I feel happy participating	17	3	2	0	0	94%	Very Positive
2	Using this learning module makes classroom learning more enjoyable	15	6	1	0	0	93%	Very Positive
3	I do not feel bored studying with the module	14	4	4	0	0	89%	Very Positive
4	For me, the module is very interesting.	22	0	0	0	0	100%	Very Positive
5	I completed the SPLDV learning using the module.	13	8	1	0	0	91%	Very Positive
6	I am able to understand the SPLDV material through the use of the module.	16	6	0	0	0	95%	Very Positive
7	I try to be more active in learning mathematics on the SPLDV topic.	19	2	1	0	0	96%	Very Positive
8	After studying with the module, I feel more motivated and enjoy learning mathematics.	18	4	0	0	0	96%	Very Positive
Average Percentage of Positive Responses							95%	Very Positive

Based on the teacher's and students' responses during the product trial, which involved one teacher and 22 students, it was found that the learning module is practical and effective for use. The teacher's response yielded an average score of 4.27, categorized as practical. Student responses from the questionnaire indicated a very positive perception of the module, with an average effectiveness rating of 95%, demonstrating that the product developed by the researcher meets the criteria for practicality and effectiveness. Additionally, comments highlighted that the learning module is engaging, easy to understand, and not monotonous.

Evaluation

Based on the implementation stage, the learning module must undergo evaluation. During the evaluation phase, final revisions were made to the developed product. The researcher then determined that the learning module is highly feasible for use, based on the results of the product validation.

RESULTS

This study produced a product, namely a mathematics learning module on the topic of SPLDV using the Desmos Web, which was tested for validity, practicality, and effectiveness. The module contains material on systems of linear equations in two variables using four methods:

substitution, elimination, combined, and graphical methods. The module development process followed the ADDIE model.

Based on the conducted study, the mathematics learning module on SPLDV using the Desmos Web was proven to meet the following criteria: highly valid according to subject-matter expert evaluation, highly valid according to media expert evaluation, practical based on the analysis of teacher response questionnaires supported by student response data, which were rated very positively, and effective, as evidenced by the increase in students' average learning outcomes. Therefore, it can be concluded that the product developed by the researcher—the mathematics learning module on SPLDV using the Desmos Web—is valid, practical, and effective for use in the learning process.

CONCLUSION

The mathematics learning module on SPLDV using the Desmos Web was developed by applying the ADDIE model. The feasibility scores, following validation by two media experts and subject-matter experts, were 4.48 and 4.56, respectively, indicating that the mathematics learning module on SPLDV using the Desmos Web is highly suitable for development.

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