SJME (Supremum Journal of Mathematics Education)
Vol.10 No.1, January 2026, pp. 197-211
ISSN: 2548-8163 (online)| ISSN: 2549-3639 (print)
DOI: 10.35706/sjme.v10i1.13190

Development of an Electronic Module to Improve Mathematical Representation in Two Variable Linear Equations

Hamdan Sugilar [1]*, Iyon Maryono[2], Wahyudin[3], and Sani Insan Muhamadi[4]
[1*,3] Universitas Pendidikan Indonesia, Indonesia
[2]UIN Sunan Gunung Djati Bandung, Indonesia
[4]The University of Sydney, Australia
**Corresponding author*
Email: hamdansugiar@upi.edu[1]* , iyonmaryono@uinsgd.ac.id[2], wahyudin@upi.edu[3], smuh0654@uni.sydney.edu.au[4]

Article Information
Received November 15th, 2025
Revised December 23th, 2025
Accepted January 2nd, 2026

Diterima 15 November 2025
Direvisi 23 Desember 2025
Disetujui 02 Januari 2026

Keywords:
Electronic Module; Concrete-Representational-Abstract Representation Ability; SPLDV

Kata kunci:
Modul Elektronik; Kemampuan Representasi Konkret-Representasional-Abstrak; SPLDV

ABSTRACT

This study aims to develop an HTML5 package-based E-Module on the material of the Two-Variable Linear Equation System (SPLDV) which is valid and practical. The results of the mathematical representation test of students solving SPLDV problems on 12 students obtained an average score of 75 in the good category. The research method used is research and development with a 4D development model, which includes the Define, Design, Develop, and Disseminate stages. Data collection techniques include media validation tests through media and material expert validation forms, mathematical representation tests, and questionnaire distribution. Data analysis by calculating the percentage of media and material expert assessments and calculating questionnaire responses and mathematical representation test scores. The results of the media expert review show that the validity of the e-module from the media and material aspects is very valid. The practicality test on a large scale shows a percentage of 78.91% which is classified as practical. Student responses to this module are very good. In addition, the test results for 12 students showed an average score of 75 for completing SPLDV questions, which is considered good. Overall, it was concluded that the developed HTML5 package-based SPLDV e-Module met the criteria for validity, practicality, and effectiveness for use in learning.

ABSTRAK

Penelitian ini bertujuan untuk mengembangkan E-Modul berbasis HTML5 Package pada materi Sistem Persamaan Linear Dua Variabel (SPLDV) yang valid dan praktis. Pada hasil tes representasi matematis siswa menyelesaikan soal SPLDV pada 12 siswa diperoleh rata-rata nilai 75 kategori baik. Metode penelitian yang digunakan adalah Research and Development dengan model pengembangan 4D, yang meliputi tahap *Define* (Pendefinisian), *Design* (Perancangan), Develop (*Pengembangan*), dan *Disseminate* (Penyebaran). Teknik pengumpulan data melalui uji validasi media melalui form validasi ahli media dan materi, tes representasi matematis, dan penyebaran angket. Analisis data dengan menghitung persentase penilaian ahli media dan materi, dan menghitung respon angket dan nilai tes representasi matematis. Hasil review ahli media menunjukkan validitas e-modul dari aspek media dan materi sangat valid. Uji kepraktisan pada skala besar menunjukkan persentase 78,91% yang tergolong praktis. Respon siswa terhadap modul ini sangat baik. Selain itu, hasil tes pada 12 siswa menunjukkan rata-rata nilai menyelesaikan

soal SPLDV sebesar 75 dalam kategori baik. Secara keseluruhan, disimpulkan bahwa E-Modul SPLDV berbasis HTML5 Package yang dikembangkan telah memenuhi kriteria valid, praktis, dan efektif untuk digunakan dalam pembelajaran.

INTRODUCTION

The aim of mathematics learning is to enable students to understand and meaningfully grasp the substance of mathematics. Students can achieve this objective through the development and use of representations of mathematical ideas (Maryati & Suryaningsih, 2021). One way to provide understanding and meaning is by connecting mathematical material to relevant learning situations through mathematical representation. Mathematical representation skills are crucial to the mathematics learning process because they are needed to identify mathematical objects, solve problems, and provide explanations (Sani et al., 2020). The ability to represent mathematical ideas includes skills in changing notation, symbols, tables, images, graphs, diagrams, creating equations or other mathematical expressions in various forms (Mahendra et al., 2019). The process of representing mathematical ideas involves transforming a problem or idea into a different form. Duval, (2017) Representation can also be a complex of signs and their associations, produced according to rules that allow the description of a system, process, or set of phenomena. The term "representation" can be interpreted in various ways, including as follows: corresponding to, indicating, depicting, embodying, encoding, evoking, labeling, meaning, producing, referring, suggesting, or symbolizing (Goldin, 2003).

However, field conditions indicate a gap between these ideal objectives and student achievement. Previous research highlights that students often face difficulties in the Two-Variable Linear Equation System (SPLDV) material. Students' ability to understand mathematical concepts in SPLDV is generally low, recorded at 35.90%, due to factors such as lack of concentration, irregular study habits, and unengaging learning methods (Umam & Zulkarnaen, 2022), the most common difficulties experienced by students are at the stage of creating mathematical models and applying strategies to solve mathematical modeling problems (Taufiq, 2022) SPLDV students' problem-solving abilities are classified as low (Saputra et al., 2023), students still have difficulty solving SPLDV problems because they still have difficulty understanding the SPLDV concept, and changing story problems into mathematical form (Maryani & Setiawan, 2021). Low-ability students have low mathematical communication skills in each SPLDV material indicator (Gardenia et al., 2021) Students with high, medium, and low abilities do not have the knowledge necessary to confirm the accuracy of the results, which causes students to doubt the correct solution to the SPLDV material (Pathuddin et al., 2024). The weaknesses of high school students in linear programming material are specifically in two aspects of mathematical representation, namely in interpretation and verification abilities, and conclude that there is an urgent need for improvement in the learning process of mathematical modeling (Muharani et al., 2025).

To overcome student difficulties and boredom of students in learning mathematics, it is necessary to develop a product in the form of an e-module (Aisy et al., 2020), the average value of the conceptual understanding test of students who used the Lectora Inspire Interactive e-module on the SPLDV material was 71.5, which was in the moderate category. The student response to learning using the animated video on the SPLDV material was

76.1% in the good category (Tetriyani et al., 2024). In delivering material, educators need effective strategies to facilitate learning, so that they can increase students' learning motivation and create efficient learning (Sukandi dkk, 2024). One strategy to increase student motivation and make students more active learners is to use technology-based learning media (Fatrina et al., 2025; Husna & Supriyadi, 2023). According to Darhim (2014), learning media is anything used to send messages or information from one source to another. This is in line with research conducted by Kariadinata dkk., (2018) which states that learning media must be able to convey messages and stimulate the thoughts, feelings, and desires of the audience (students) so that they can encourage the learning process in students. Media, which is essentially part of the learning process, plays a very important role in today's era of information and technology that continues to develop. Educators who are sufficiently equipped to prepare themselves for teaching are one of the main factors in the success of technology-based learning (Sugilar dkk., 2023). One of the learning alternatives that demands student activeness in the digital era is multimedia-based learning (Susilawati et al., 2018). According to Sugilar, (2019), multimedia, as a product of digital technological advancements, is capable of displaying messages in the form of text, animation, video, graphics, and audio. Multimedia plays a vital role in learning because it allows students to learn anytime, anywhere, without the constraints of space and time (Kariadinata et al., 2018), and can also improve students' mathematical representation skills by presenting material in a more engaging format (Farhan & Umbara, 2021). E-modules are a learning medium that utilizes technological advances to present material independently in electronic format to achieve learning objectives (Setiadi & Zainul, 2019).

The development of this e-module addresses the need for interactive, flexibly accessible self-teaching materials, especially for SPLDV materials that often require visualization for in-depth understanding. This study presents various ways to solve problems in SPLDV material and a strong understanding of the material so that students are not only able to solve problems but also to represent them in various forms, one of which is through the Concrete-Representational-Abstract (CRA) approach. Of course, this can be an alternative to completing SPLDV, which students have been confused about completing. The novelty of this research lies in developing an HTML5 package-based E-module for SPLDV material that specifically integrates the CRA approach to solving SPLDV problems using rectangular representations, while also conveying the methods generally used to solve SPLDV by elimination, substitution, and mixing. This integration is designed to systematically build and measure students' mathematical representation abilities, which the researchers say have not been widely explored in the development of similar e-modules.

METHOD

This research uses a Research and Development (R&D) approach. Research and development is an effective product development process for developing products rather than testing theories (Gay dkk., 2012). Meanwhile, according to Borg & Gall (1983), educational research and development is an activity aimed at developing and validating educational products by analyzing research results, testing them, and correcting errors. This is in line with what was conveyed by Sugiyono (2013), Research and development (R&D) is a type of research conducted to produce a product and test its effectiveness. Data collection in this study was conducted using three main instruments. First, a media and material validation test using a validation form completed by media and material experts. Second, a mathematical representation ability test was given to students to measure their understanding of the SPLDV material. Third, a user response questionnaire was distributed to students to

assess the practicality and attractiveness of the e-module. For data analysis, quantitative data from the expert validation form and response questionnaire were analyzed by calculating the percentage of scores, which were then interpreted against applicable feasibility and practicality criteria.

Qualitative data in the form of suggestions and comments from experts and respondents were analyzed descriptively as material for product revision. Meanwhile, mathematical representation test scores were analyzed by calculating the average score and the percentage of learning completion, which were used to assess the e-module's effectiveness in supporting students' achievement of mathematical representation skills. The model used in this study is the development of a 4D model consisting of four stages, namely, Define, Design, Develop, and Disseminate (Thiagarajan dkk., 1974). This model was chosen to produce an e-module SPLDV assisted by the HTML5 Package with valid mathematical representation capabilities and is suitable for dissemination.

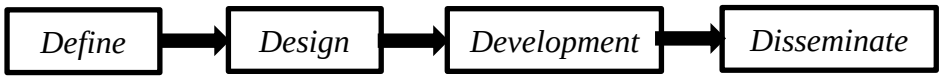


Figure 1. 4D Model

Based on **Figure 1**, the development process followed the 4D model—Define, Design, Develop, and Disseminate—proposed by Thiagarajan et al. (1974). In the Define stage, the researchers identified and clarified the learning needs by collecting information about the SPLDV e-module to be developed and analyzing the mathematics learning requirements for Grade VIII in the first semester. This stage included front-end analysis, learner analysis, task analysis, and concept analysis to ensure that the product was aligned with students' characteristics and the demands of the content.

In the design stage, an SPLDV e-module was planned using an HTML5 Package to support mathematical representation skills. Media selection was carried out based on the results of the initial analyses so that the chosen e-module would match students' needs and allow learning to take place flexibly at school or at home. After that, the presentation format was determined to suit the material, guiding how content such as explanations of SPLDV concepts, practice activities, and evaluation tasks would be organized and displayed. These decisions were then consolidated into an initial design, resulting in a draft SPLDV e-module developed with the HTML5 Package and enriched with engaging learning content.

The Develop stage focused on refining the initial product into an effective final version. Although the earlier stages produced a preliminary e-module, revisions were still required based on evaluation results and feedback. During this stage, the researchers prepared validation instruments and storyboards, and expert validation was conducted before the student trial to ensure that both the SPLDV material and the media design were accurate and appropriate. Validation was carried out by expert lecturers and teachers, and the feedback from this initial review was used to revise the product. The revised version was then re-evaluated by material and media experts to confirm that the e-module was feasible for implementation.

In the Disseminate stage, the e-module was distributed and tested on a limited basis in one junior high school in Sukabumi Regency. The trial involved 12 student respondents, consisting of 10 students from Grade IX and 2 students from Grade VIII, to examine the practicality of using the e-module in a real learning context.

RESULTS AND DISCUSSION

The define stage is the initial stage undertaken by the researcher in developing the SPLDV e-module using the HTML5 package. This stage was conducted to identify the learning needs in junior high schools for linear equations, or SPLDV. The researcher conducted four stages in this definition process. First, through preliminary and final analysis, the researcher directly observed the learning process of eighth-grade students and found that formal learning activities take place from Monday to Friday. The next analysis was a curriculum analysis to ensure that the material to be taught aligns with school standards and student needs. This analysis was conducted through interviews with eighth-grade math teachers. The results of this analysis indicated that the eighth graders in the research trial implemented the independent curriculum. Next, the researcher determined the mathematics material that would serve as the main topic for the e-module to be developed. Based on the curriculum analysis, one of the materials in the Merdeka Curriculum, intended for eighth grade, is SPLDV, found in semester 2, in chapter 8. Therefore, the researcher will prepare learning media tailored to the curriculum used. Next, student analysis was conducted to examine the characteristics of eighth-grade learners. Interviews with teachers and several students indicated that many students still perceive mathematics as difficult and abstract, which contributes to negative attitudes toward the subject. In addition, learning that depends heavily on printed textbooks was reported to reduce students' interest, causing boredom and difficulties in following lessons, which in turn weakens their motivation to learn mathematics.

The third component, task analysis, focused on identifying the learning outcomes that should be achieved through the SPLDV material presented in the e-module. This analysis was guided by the mathematics textbooks used in junior high schools and was used to determine the main tasks students must master, as well as to classify supporting skills needed to reach the minimum expected competencies. Based on the task analysis, the learning outcomes that guide the development of the e-module are shown in **Table 1**.

Table 1. Learning Outcomes

Learning Outcomes (LO) for 2024 Algebra
At the end of phase D, students can recognize, predict, and generalize patterns in the form of arrangements of objects and numbers. They can express a situation in algebraic form. They can use the properties of operations (commutative, associative, and distributive) to produce equivalent algebraic forms. Students can understand relations and functions (domain, codomain, range) and present them in the form of arrow diagrams, tables, sets of ordered pairs, and graphs. They can distinguish some nonlinear functions from linear functions graphically. They can solve linear equations and inequalities in one variable. They can present, analyze, and solve problems using relations, functions, and linear equations. They can solve systems of linear equations in two variables using various problem-solving methods.

Figure 2. Concept Map

Finally, concept analysis was carried out to determine the scope and organization of the SPLDV content to be included in the e-module. The result of this stage was a concept map, presented in **Figure 2**, which illustrates how the SPLDV material would be structured. By referring to the learning objectives and concept relationships displayed in the concept map, the researcher was able to decide what content should appear in the SPLDV e-module developed with the HTML5 package to support mathematical representation skills.

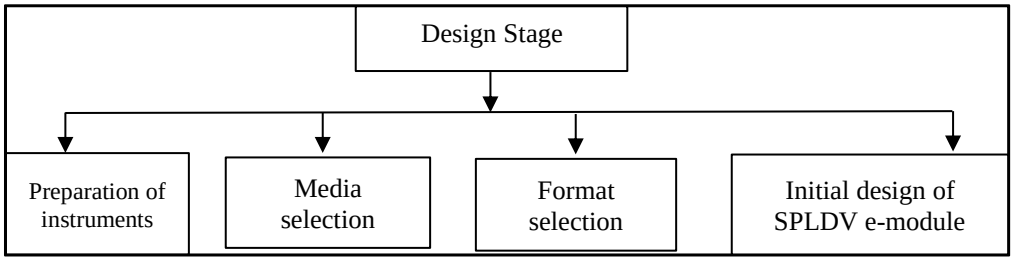


Figure 3. Design Stage

The next development stage is the design stage. The purpose of the design stage is to design the SPLDV e-module to be developed. As seen in **Figure 3**, in carrying out this stage, the researchers went through four main processes: instrument development, media selection, format selection, and the initial design of the SPLDV e-module. In the instrument development process, the instruments prepared for this study included a media and materials expert validation sheet, a question validation sheet, a practicality questionnaire, a student response questionnaire, and SPLDV material evaluation questions. The development of these instruments began with constructing grids and compiling statements for the validation and question instruments, as well as designing questions tailored to indicators of mathematical representation ability.

The media selection process determined that the learning media developed was an electronic-based SPLDV module supported by the HTML5 package. This package, along

with other supporting software, was selected because it provides various features and templates that enhance interactivity and engagement in the SPLDV e-module. Furthermore, the format of the SPLDV e-module was determined based on the results of the analysis stage, which included the initial and final analyses, student analysis, concept analysis, task analysis, and the formulation of learning objectives. Finally, the initial design involved developing the structure and components of the SPLDV e-module. Once the elements and content to be presented were identified, the researchers created a structural design supported by the HTML5 package to facilitate the development of students' mathematical representation skills. The detailed description of the initial design of the SPLDV e-module is presented in **Table 2**.

Table 2. Cover of SPLDV E-Module

Component	Description
E-module identity	The title reads: SPLDV E-Module
	Sub subject matter: System of Linear Equations Two
Target	For SMP/MTs class VIII
Compiler	Development Team

The first component is the SPLDV e-module cover, which displays the e-module identity, targets, and compilers, as shown in **Table 2**. The second component is the introduction, which consists of the introduction, scope of competencies, instructions for using the e-module, and concept map presented in **Table 3**.

Table 3. Introduction Section of the SPLDV E-Module

Component	Description
Introduction	Foreword Table of Contents
Scope of competence	Learning Outcomes (LO) Learning Objectives (LOb)
Instructions for use	Instructions for using the SPLDV e-module
Concept maps	The flow of material that will be explained in the e-module

The e-module components presented are based on those outlined by the Ministry of Education and Culture (2017) and conclude with a developer profile. The e-module flowchart is also presented.

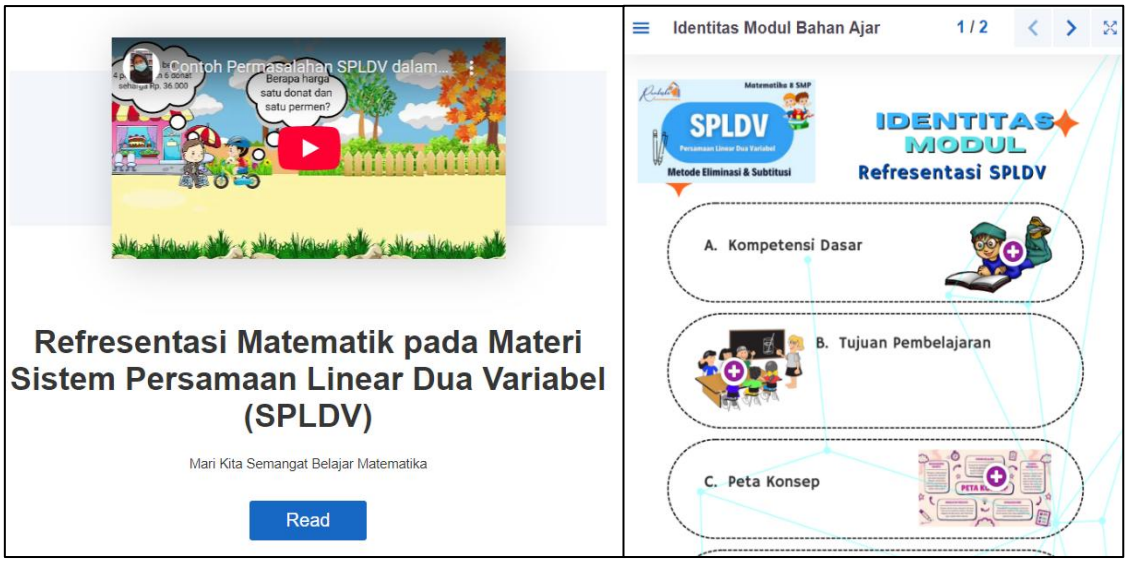


Figure 4. Display of the HTML5-Based E-Module SPLDV Material Package

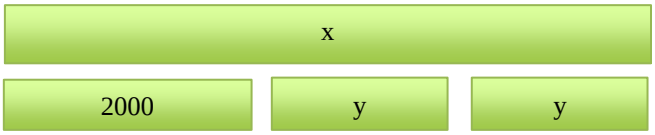
Figure 4 displays the HTML5 package-based e-module, which includes basic competencies, learning objectives, and concept maps. In addition to the buttons on each menu, there is a video that discusses the SPLDV material and how to complete it. The Concrete-Representational-Abstract (CRA) approach is a step-by-step instructional framework rooted in Bruner's theory, designed to guide students toward a deeper understanding of mathematical concepts. The first stage, Concrete, involves modeling problems using real, physical objects, such as pieces or blocks. Next, the representational stage moves to pictures, dots, or diagrams as semi-real representations of these objects. Finally, the Abstract stage introduces entirely abstract mathematical symbols, such as numbers and operation signs, to solve problems. In this sequence, students build their understanding from concrete, hands-on experiences to abstract, symbolic thinking.

Based on research (Witzel, 2005), the use of concrete materials and the CRA method has been shown to significantly improve students' understanding and learning outcomes in mathematics. Interaction with concrete objects helps improve procedural memory retention by engaging multiple senses (visual, auditory, tactile, and kinesthetic), which is particularly beneficial for intermediate-level students. Under teacher guidance, students who learned using the CRA approach to solving algebraic equations outperformed their peers who received traditional instruction. CRA provides an opportunity to enhance interaction with the content and increase response frequency for all students. After receiving CRA instruction, students' conceptual understanding of equivalent fractions significantly improved. During the final test, students will again use representational images to guide their problem-solving (Butler et al., 2003). This method not only increases interaction with the material and the frequency of student responses but also significantly deepens conceptual understanding, for example, in equivalent fractions, where students independently use representational images as a guide when completing evaluation questions.

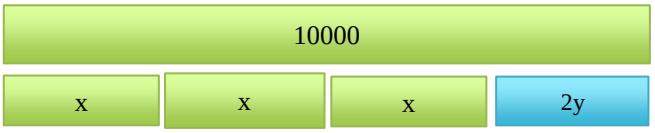
The e-module created displays mathematical representations of squares and rectangles using the CRA approach. The following is a method for solving SPLDV developed by (Darhim, 2022) According to researchers, this includes pictorial representations and the use of square or rectangular boxes to represent numbers or variables. Examples of solving SPLDV problems using pictorial representation or using square or rectangular boxes.
Determine the solution to SPLDV:

$$3x + 2y = 10.000$$
$$x - 2y = 2.000$$

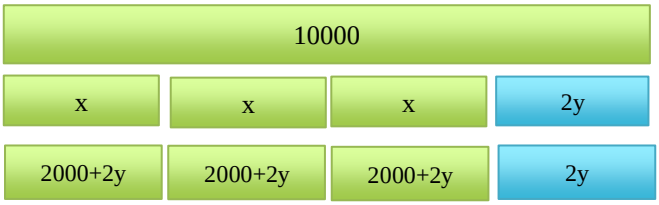
The equation system can be derived from the following story problem: "The price of 3 boxes of food (which contain a number of small packages) and 2 small packages is Rp. 10,000. Meanwhile, the price of 1 box of food (the same as above) after taking 2 small packages is Rp. 2,000. The question is: how much is 1 box of food and 1 small package?
Suppose the price of 1 box of food is x, and 1 small package is y. Representation of the equation$x - 2y = 2000$ changed to $x = 2y + 2000$ as follows:



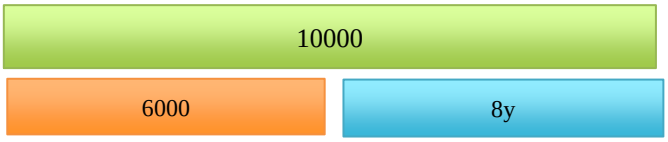
Representation of $3x + 2y = 10.000$



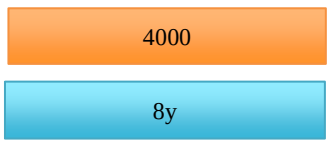
After x is replaced with rectangle 2 and rectangle $2y$, the following representation is obtained.



After manipulation it is obtained



After simplification, namely by cutting rectangle 4, the following representation is obtained.



So the equation is obtained $8y = 4000$ or $y = 500$. Next, to determine the value, then $x = 2 \times 500 + 2000 = 3000$. From the question, the answer is that the price of 1 box of food is Rp. 3000 and 1 small package is Rp. 500.

The validation assessment of the HTML5 package-assisted E-Module using the mathematical representation approach for the two-variable linear equation system is divided into two stages: validation stage 1 and validation stage 2. This validation was carried out by a media expert validator. The following are the results of the validity test on the HTML5

package-assisted E-Module using the mathematical representation approach for the two-variable linear equation system material stage 2, presented in **Table 4**.

Table 4. Results of Media Expert Validation Test

No	Aspect	Validator 1	
		Score	Percentage
1.	Appearance	18	78.26 %
2.	Language	10	83.33 %
3.	Visual Communication	26	74.29 %
4.	Presentation	17	85.00 %
Average Percentage of Overall Score		80.22 %	
Criteria		Valid	

Based on **Table 4**, the media expert validation results were 80.22%, indicating that the created media is valid for use. Validation was conducted by a material expert who was also a grade 8 mathematics teacher. The researcher conducted the validation before conducting a small-scale trial. The validator provided assessments, suggestions, and feedback on the content and suitability of the HTML5 package interactive e-module. The validator's suggestions and input served as guidelines for the researcher in making changes to the media. The following are the results of the material expert validator's assessment of the material contained in the HTML5 package interactive e-module.

Tabel 5. Results of the Material Expert Validation Test

No	**Aspect**	**Validator 2**	
		Score	**Percentage**
1.	Conceptual Truth	20	100 %
2.	Material Compiler	28	80 %
3.	Potential for Implementation	13	86.67 %
Average Percentage of Overall Score		88.87 %	
Criteria		Very Valid	

Table 5 presents the results of the material validity test, which yielded an overall score of 88.87% and met the very valid criteria, so there is no need to carry out stage 2 validation with material experts. In the validity of the E Module Assisted by HTML5 Package through the mathematical representation approach of the material on the system of linear equations of two variables, tested in terms of media, it produced a final score of 80.22% and 88.87% in the validity test with material experts. Overall, the validity of the E Module assisted by the HTML5 package, using the mathematical representation approach, for the system of two-variable linear equations, was 84.55% and met very valid criteria. Therefore, the E Module, assisted by HTML5 package, using the mathematical representation approach to the system of linear equations of two variables, can be used in the trial stage for students.

The practicality of the HTML5 package-assisted e-module, as measured by the SPLDV mathematical representation approach, is reflected in the results of the practicality questionnaire administered to students after receiving mathematics instruction using the HTML5 package-based interactive e-module. The following are the results obtained from the practicality test.

Tabel 6. Analysis of the Practicality of E-Module Media

Aspect	Indicator	Percentage	Percentage of Each Aspect	Category	Category
Effectiveness	1	82	81,25 %	Practical	Practical
	2	83			
	3	80			
	4	80			
Attraction	5	78	78,67 %	Practical	
	6	78			
	7	80			
Efficiency	8	76	76,83 %	Practical	
	9	77			
	10	75			
	11	80			
	13	75			
	14	78			

Based on **Table 6**, the media's practicality for the first indicator, effectiveness, with a percentage of 81.25%, is included in the practical criteria. Furthermore, for the second indicator regarding attractiveness, it receives a score of 78.67% based on the criteria. Furthermore, for the third indicator regarding efficiency, it receives a 76.83% score under the practical criteria. After conducting small- and large-scale trials, it can be concluded that the HTML5 Package-Assisted E-Module, through a mathematical representation approach to the material on two-variable linear equation systems, has met the practical requirements, with an overall large-scale percentage of 78.91% against the practical criteria.

The Disseminate stage tests the limited effectiveness of the HTML5 Package-Assisted E-Module using a mathematical representation approach for material on two-variable linear equation systems. The following are the results of the analysis of the effectiveness of the HTML5 Package-Assisted E-Module, using a mathematical representation approach, for the material on two-variable linear equation systems and mathematical representation abilities. When solving SPLDV problems, which method is often used?

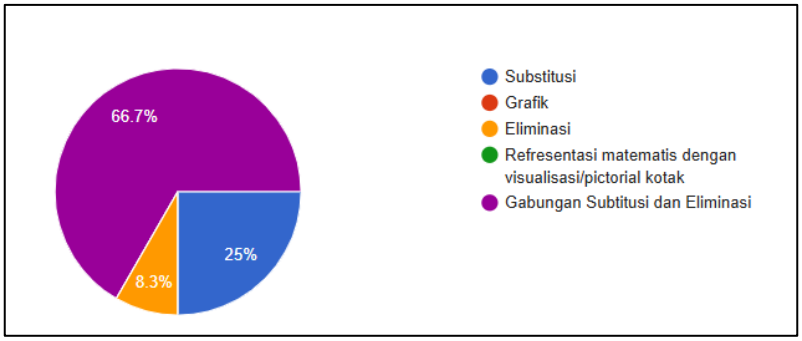


Figure 5. Student Responses on the Methods Used in Solving Problems About SPLDV

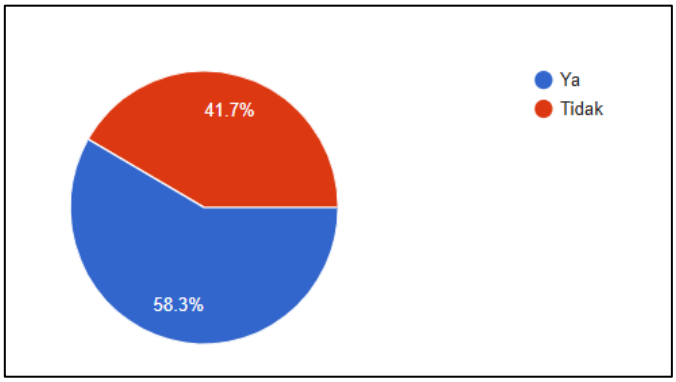


Figure 6. Student Responses on Whether They Have Seen or Used the Mathematical Representation Teaching Material Module

In **Figure 5**, student responses regarding the methods used in solving problems about SPLDV, 66.7% used a mixed method, 25% using substitution, and the rest used elimination; no one used the mathematical representation method with a square or rectangular approach. In **Figure 6**, student responses regarding whether they had ever seen or used the mathematical representation teaching material module showed that 58.3% had seen it, and the remaining 41.7% had never seen it. 100% of respondents stated that the e-module created could help understand SPLDV, with the assessment Give the teaching material module

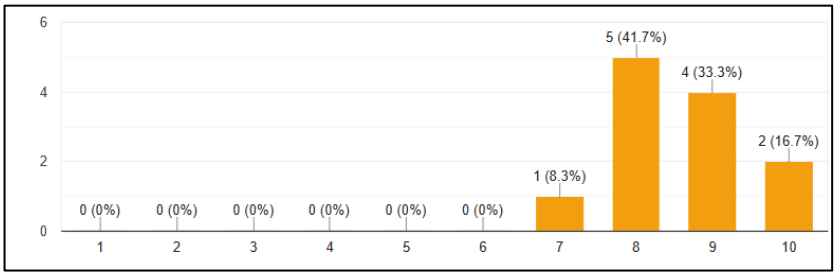


Figure 7. Student Assessment of the Mathematical Representation Module

From **Figure 7**, it shows that students assess the module in the range of 85,80 is in the interval $80 \leq X \leq 100$ in the very good or very high category. Based on the results of the mathematical representation test of students completing SPLDV problems in 12 students, an average score of 75 is obtained in the interval $70 \leq X < 80$ with a good category. The validation results show that the HTML5 package-based E-Module for SPLDV material is declared very valid. The validation score reached 84.55%, which is the average of the media expert's assessment of 80.22% and the material expert's 88.87%. Thus, this e-module has met the eligibility requirements to be tested on students. Effectiveness at 81.25% achieved the highest score. This indicates that the E-Module is highly functional in achieving the learning objectives. Students feel that the module's content and activities clearly support understanding of the SPLDV material, especially since there are other ways to solve SPLDV problems using rectangles. The 78.67% attractiveness score falls in the practical category; it indicates that the interface design, visual presentation, and multimedia appeal in the E-Module are sufficient to foster students' interest and motivation to learn. The use of mathematical representation e-modules helps students understand SPLDV material well, which can be observed from student responses in the very good category and the increase in

students' mathematical representation abilities in the moderate category (Agrisa et al., 2025; Salsabila et al., 2023).

The efficiency level of 76.83%, while still practical, is the lowest score. This may indicate minor challenges with ease of navigation, clarity of instructions, or the time required to complete the module. This finding could be an important note for technical improvements, such as simplifying the flow or speeding up access times. The testing process was conducted in two stages at small and large scales, a credible procedure in development research. The overall score of 78.91% from the large-scale test provides confidence that practical decisions are based on stable and reliable data, not the results of limited trials. Therefore, it can be concluded that this E-Module meets the requirements for feasibility of implementation in a real learning setting. This product is not only theoretically valid but also proven to be usable by the target users.

CONCLUSION

The development of an HTML5 package-based E-Module on SPLDV material, focusing on students' mathematical representation abilities using the Concrete-Representational-Abstract approach, can help students understand the material and solve SPLDV problems effectively. The mathematical representation approach with squares or rectangles provides new experiences for students. With the CRA sequence in this e-module, students build their understanding from real, hands-on experience to abstract symbolic thinking. The results of the media expert review indicate that the validity of the e-module from the media and material aspects is very valid. The developed HTML5 package-based SPLDV E-Module meets the criteria for validity, practicality, and learning effectiveness. This finding directly answers one of the Research objectives, namely, producing a practical product. The data presented is objective and measurable empirical evidence that the developed E-Module has met the criteria of practicality, thus strengthening the claim of this product's superiority as an alternative learning media. For further research, it can be applied to the use of e-modules or mathematical representations in other mathematical materials.

REFERENCES

Agrisa, F., Nuraeni, Z., & Sari, N. (2025). Mathematical representation ability of VIII grade students in linear equation using math literacy-based E-module. *Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika*, *11*(1), 33–41. https://doi.org/10.29407/jmen.v11i1.21819

Aisy, D. R., Farida, F., & Andriani, S. (2020). Pengembangan e-modul berbantuan Sigil software dengan pendekatan saitifik pada materi sistem persamaan linier dua variabel (SPLDV). *Edu Sains: Jurnal Pendidikan Sains Dan Matematika*, *8*(1), 61–71. https://doi.org/10.23971/eds.v8i1.1499

Borg, W. R., & Gall, M. D. (1983). Educational Research: An Introduction. *British Journal of Educational Studies*, *49*(3), 362–365.

Butler, F. M., Miller, S. P., Crehan, K., Babbitt, B., & Pierce, T. (2003). Fraction instruction for students with mathematics disabilities: Comparing two teaching sequences. *Learning Disabilities Research & Practice*, *18*(2), 99–111.

Darhim. (2014). Dasar-dasar Pengetahuan tentang Media Pembelajaran Matematika. *Workshop Matematika*, 1–41.

Darhim, D. (2022). *Sistem Persamaan Linier Dua Variabel (SPLDV): Membangun, Solusi, Koneksi*. PPT Kuliah Pendidikan Matematika Kontemporer.

Duval, R. (2017). *Understanding the mathematical way of thinking-The registers of semiotic representations*. Springer.

Farhan, E., & Umbara, U. (2021). Implementasi Pembelajaran Berbasis Multimedia Terhadap Kemampuan Representasi Matematika. *SJME (Supremum Journal of Mathematics Education)*, *5*(1). https://doi.org/10.35706/sjme.v5i1.3949

Fatrina, A., Nuraeni, Z., Mulyono, B., Yukans, S. S., & Mansur, N. (2025). Kemampuan Representasi Matematis Siswa Kelas VII Menggunakan Problem Based Learning Berbantuan E-LKPD. *SJME (Supremum Journal of Mathematics Education)*, *9*(1), 197–213. https://doi.org/10.35706/sjme.v9i1.187

Gardenia, N., Herman, T., Juandi, D., Dahlan, T., & Kandaga, T. (2021). Analysis of mathematical communication skills of class 8 students on two-variable linear equation systems (SPLDV) concept. *Journal of Physics: Conference Series*, *1806*(1), 12073. https://doi.org/10.1088/1742-6596/1806/1/012073

Gay, L. R., Mills, G. E., & Airasian, P. (2012). Educational Research Competencies for Analysis and Applications. Tenth Edition. In *Jurnal Sains dan Seni ITS*.

Goldin, G. A. (2003). Representation in school mathematics: A unifying research perspective. *A Research Companion to Principles and Standards for School Mathematics*, 275–285.

Husna, K., & Supriyadi, S. (2023). Peranan Manajeman Media Pembelajaran Untuk Meningkatkan Motivasi Belajar Siswa. *AL-MIKRAJ Jurnal Studi Islam Dan Humaniora (E-ISSN 2745-4584)*, *4*(1), 981–990. https://doi.org/10.37680/almikraj.v4i1.4273

Kariadinata, R., Juariah, Sugilar, H., & Nurdiansyah, R. (2018). *Cara Mudah Membuat dan Menggunakan Alat Peraga Matematika*.

Mahendra, N. R., Mulyono, M., & Isnarto, I. (2019). Kemampuan Representasi Matematis dalam Model Pembelajaran Somatic, Auditory, Visualization, Intellectually (SAVI). *PRISMA, Prosiding Seminar Nasional Matematika*, *2*, 287–292.

Maryani, A., & Setiawan, W. (2021). Analisis Kesulitan Peserta Didik Kelas VIII dalam Menyelesaikan Soal Sistem Persamaan Linear Dua Variabel (SPLDV) di MTs Atsauri Sindangkerta. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *5*(3), 2619–2627. https://doi.org/10.31004/cendekia.v5i3.915

Maryati, I., & Suryaningsih, F. (2021). Kemampuan Representasi Matematis Ditinjau dari Kemandirian Belajar dengan Model Pembelajaran Berbasis Masalah dan Inkuiri. *Prisma*, *10*(2), 244–254. https://doi.org/10.35194/jp.v10i2.1308

Muharani, A., Kurniadi, E., & Araiku, J. (2025). Kemampuan Representasi Matematis Siswa dalam Pembelajaran Pemodelan Matematika pada Materi Aplikasi Program Linear. *SJME (Supremum Journal of Mathematics Education)*, *9*(1), 61–73. https://doi.org/10.35706/sjme.v9i1.186

Pathuddin, P., Hamidah, D., Panggalo, S., Hakim, Z. A., Suwardin, M., Bakri, B., & Awuy, E. (2024). Students' Polya problem solving skills on system of linear equations with two variables bases on mathematical ability. *AIP Conference Proceedings*, *3046*(1).

Salsabila, S., Anriani, N., & Santosa, C. A. H. F. (2023). Pengembangan e-modul pada android menggunakan kodular untuk meningkatkan kemampuan representasi matematis siswa. *Teorema: Teori Dan Riset Matematika*, *8*(1), 1–10. https://doi.org/10.25157/teorema.v8i1.8704

Sani, L. D. Y., Santia, I., & Katminingsih, Y. (2020). *Analisis Kemampuan Representasi Matematis Siswa SMA pada Materi Trigonometri*. Universitas Nusantara PGRI Kediri.

Saputra, Y. P., Wulandari, N. P., & Hikmah, N. (2023). Kemampuan Pemecahan Masalah

Matematika Siswa pada Materi Sistem Persamaan Linear Dua Variabel. *Journal of Classroom Action Research*, *5*(1), 85–94.

Setiadi, T., & Zainul, R. (2019). Pengembangan E-Modul Asam Basa Berbasis Discovery Learning Untuk Kelas XI SMA/MA. *EduKimia*, *1*(1), 21–27. https://doi.org/10.24036/ekj.v1i1.104019

Sugilar, H. (2019). Multimedia Matematika di Era Digital. *SENTER 2019: Seminar Nasional Teknik Elektro 2019, November 2019*, 442–451.

Sugilar, H., Mangkuwibawa, H., & Yudhiantara, R. A. (2023). *Computer Technology-Based MBKM To Develop Mathematics Education Students' Metacognition and Metasklill Perspective*. *8*(2), 106–116.

Sugiyono, D. (2013). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*.

Sukandi, H. R., Rahayu, Y. N., & Safitri, N. R. (2024). *Penggunaan Alat Peraga dalam Meningkatkan Minat Belajar Matematika Siswa*. *8*(1), 70–80.

Susilawati, W., Maryono, I., & Maimunah, S. (2018). *The development of Adobe Flash-based interactive multimedia to enhance students ' mathematical communication skills*. https://doi.org/10.1088/1757-899X/434/1/012011

Taufiq, D. A. (2022). Kemampuan pemecahan masalah matematis siswa smp pada materi sistem persamaan linear dua variabel. *Plusminus: Jurnal Pendidikan Matematika*, *2*(2), 303–314. https://doi.org/10.31980/plusminus.v2i2.1106

Tetriyani, E., Jihad, A., Rachmawati, T. K., & Sugilar, H. (2024). Development of video animation media for learning a system two-variable linear equation. *KnE Social Sciences*, 423–430. https://doi.org/10.18502/kss.v9i8.15575

Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). Instructional development for training teachers of exceptional children: A Sourcebook. *Journal of School Psychology*, *14*(1), 75. https://doi.org/10.1016/0022-4405(76)90066-2

Umam, M. A., & Zulkarnaen, R. (2022). Analisis kemampuan pemahaman konsep matematis siswa dalam materi sistem persamaan linear dua variabel. *Jurnal Educatio FKIP UNMA*, *8*(1), 303–312. https://doi.org/10.31949/educatio.v8i1.1993

Witzel, B. S. (2005). Using CRA to teach algebra to students with math difficulties in inclusive settings. *Learning Disabilities: A Contemporary Journal*, *3*(2), 49–60.