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# Constructivist Liveworksheet in Two Variabel Linear Equation System

**Soffi Wdyanesti Priwantoro[1*], Syariful Fahmi[2], Ressa Fitrian[3]**

[1,2,3] Prodi Pendidikan Matematika Fakultas Keguruan dan Ilmu Pendidikan, Universitas Ahmad Dahlan Jl. Ringroad Selatan, Kragilan, Tamanan, Kec. Banguntapan, Bantul, Daerah Istimewa Yogyakarta, Indonesia

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e-mail: [1]soffiwidyanesti@pmat.uad.ac.id

*corresponding author**

**Abstrak**

Penelitian ini dilatarbelakangi oleh permasalahan yang ditemukan pada pra-penelitian di SMP Muhammadiyah 1 Godean melalui wawancara dengan guru matematika dan penyebaran angket kepada peserta didik. Diperoleh informasi bahwa masalah matematika yang berupa soal cerita sulit untuk dipahami dan juga ketiadaan media pembelajaran matematika yang menggunakan pendekatan tertentu untuk membantu peserta didik memahami masalah matematika. Oleh karena itu, penelitian ini bertujuan mengembangkan dan menguji kelayakan e-LKPD dengan pendekatan konstruktivisme berbantuan *Liveworksheets* pada materi Sistem Persamaan Linear Dua Variabel (SPLDV) kelas VIII. Penelitian ini menggunakan metode *Research and Development (R&D)* dengan model ADDIE. Subjek penelitian adalah peserta didik kelas VIII-D. Proses penilaian validasi dilakukan oleh 2 validator yaitu validator media dan materi. Setelah penilaian validasi selesai dilakukan uji coba, yang terdiri dari uji coba kelas kecil dan uji coba kelas besar. Berdasarkan analisis data diperoleh hasil penelitian menunjukkan bahwa e-LKPD mendapatkan penilaian sangat baik dari ahli materi yaitu skor 110 dan ahli media sebesar skor 89. Respon peserta didik juga tergolong baik, yaitu 97.7 pada uji coba kecil dan 96.6 pada uji coba besar. Dengan demikian, e-LKPD yang dikembangkan layak digunakan dalam pembelajaran matematika.

*Kata kunci:* *e*-LKPD, kontruktivisme, sistem persamaan linear dua variabel.

**Abstract**

This research was motivated by problems identified during the preliminary research at SMP Muhammadiyah 1 Godean through interviews with the mathematics teacher and the distribution of questionnaires to students. The information obtained indicated that mathematical problems in the form of story problems were difficult to understand and there was a lack of mathematical learning media that used a specific approach to help students understand mathematical problems. Therefore, this study aims to develop and evaluate the feasibility of an electronic student worksheet based on a constructivist approach using Liveworksheets for the topic of Systems of Linear Equations in Two Variables (SPLDV) for Grade VIII students. This research used a Research and Development (R&D) method using the ADDIE model. The research subjects were students of class VIII-D. The validation process was carried out by two validators, namely media and subject matters validators. After the validation assessment was completed, a trial was conducted, consisting of a small-scale trial and a large-scale trial. Based on data analysis, the research result indicate that electronic worksheet received a very good rating from both the subject matter expert with a score of 110 and the media expert with a score 89. Student responses were also categorized as good, with a score of 97.7 in the small group trial and 96.6 in the large group trial. Thus, the developed electronic worksheet is deemed feasible for use in mathematics learning.

*Keywords*: constructivisme, *e*-LKPD, system of linear equations in two variables.

## 1. Background

The era of globalization has accelerated the development of science and technology, so students need to be equipped with competitive skills. These skills can be developed through mathematics education that actively engages students in rediscovering concepts they have learned (Rahayu & Kusuma, 2019). In line with Sumarmo's (2005) view, mathematics education must be adapted to the demands of the times, namely equipping students with logical, systematic, objective, and critical reasoning skills.

Learning is effective when it achieves learning objectives (Setyosari, 2014). This is supported by careful planning by teachers, starting from the objectives, strategies, models, media, to strong teaching motivation (Tarihoran & Cendana, 2020). Learning media is an important component for achieving learning objectives because it makes learning more active and effective (Falahudin, 2014). According to Arsyad (2015), learning media is a learning resource that contains material, such as modules, books, worksheets, and so on. With the advancement of technology, media is no longer limited to print but also includes electronic formats. One such electronic medium is the electronic worksheet (e-LKPD). The advantages of electronic worksheets include practicality and high accessibility. According to Monalisa (2024), e-LKPD can be accessed through various devices and platforms, thereby promoting digital literacy among students. Additionally, e-LKPD is practical to use, valid, and highly effective (Sarman et al., 2023; & Sari et al., 2024).

In order for *e*-LKPD to help students understand the material and create meaningful learning, a structured learning syntax is required. The learning approach plays an important role in guiding this stage, particularly the constructivism approach, which emphasises the active involvement of students in constructing knowledge. According to Fauzi et al. (2021), Liveworksheets can be an alternative for developing e-LKPD because it provides interactive features such as illustrations, videos, and text that support the concept construction process effectively (Khikmiyah, 2021). Additionally, based on a preliminary study in class VIII-D of SMP Muhammadiyah 1 Godean, 91.6% of students stated that online-accessible LKPDs are very helpful in learning. This finding is reinforced through interviews with mathematics teachers, who explained that the current LKPDs are limited to practice questions and are unable to guide students in discovering concepts

Ministry of Education and Culture Regulation No. 103 of 2014 states that learning should be centred on students, so that students are actively involved in the learning process. One approach that can be used is constructivism, which is a learning process that actively involves students in constructing or compiling new knowledge based on experience (Suriansyah, et al., 2014).

Mathematics, as one of the disciplines studied in schools at various levels, plays a supporting role for other disciplines (Mujis & Reynolds, 2011). In schools, the objective of mathematics education is for students to understand concepts, see the relationships between concepts, and be able to solve problems effectively (Depdiknas, 2007). However, because mathematics is abstract, many students find it challenging and consider it a difficult subject. In fact, students tend to find concrete concepts easier to understand (Gunawan, 2017). Therefore, a learning approach that helps students construct their own understanding is needed. One such approach is constructivism, which emphasises that knowledge is formed by students themselves based on their learning experiences (Glasersfeld, 1995).

The material on Two-Variable Linear Equations (SPLDV) is one of the algebra topics at the junior high school level that requires an advanced understanding of the concepts of Single-Variable Linear Equations (PLSV) learned in Grade VII. Therefore, SPLDV is highly relevant to be taught using a constructivist approach, as this approach encourages students to construct their own understanding through learning experiences. Unfortunately, many students still view mathematics as a difficult and uninteresting subject. They tend to attend class merely to take attendance and pursue grades, without truly grasping the concepts being taught (Widyasari, 2015). This is reinforced by Hardiyati's (2016) statement that learning difficulties often arise because students memorise formulas without understanding the meaning behind the mathematical concepts.

Preliminary research conducted in class VIII-D of SMP Muhammadiyah 1 Godean showed that 78% of students considered mathematics difficult to very difficult, while 83.3% stated that mathematical story problems were difficult to understand, and 91.7% mentioned SPLDV as a difficult subject. Teachers also observed that students struggled to convert word problems into mathematical models and perform operations in SPLDV. Additionally, student participation in online learning was low, both in synchronous and asynchronous activities. However, when teachers

used interactive media such as *Liveworksheets*, the number of students submitting assignments increased significantly.

Previous research by Agustini and Pujiastuti (2020) and Kurniawan et al. (2019) also showed that many students were unable to translate information from story problems into mathematical form. SPLDV questions in the form of stories require a deep understanding because they involve reading, reasoning, modelling, calculating, and constructing logical answers (Nugroho, 2017). Therefore, learning media that can facilitate meaningful learning and encourage students to actively construct their own knowledge is needed. One potential solution is the development of constructivist-based e-LKPD with the assistance of Liveworksheets.

## 2. Research Method

This study used the Research and Development (R&D) method with the ADDIE model, which consists of five stages, namely analyse, design, development, implementation, and evaluation.

The analysis stage includes analysis of learning media requirements, analysis of learning materials, and analysis of learning approaches. The design stage involves the preparation of *e*-LKPD designs and assessment instruments. The development stage includes the creation and refinement of products based on input from subject matter experts and media experts. The implementation stage is carried out by testing the product with students. The evaluation stage includes assessing the product's suitability by media and material validators, as well as small and large-scale classroom trials.

Product feasibility is assessed through a validation questionnaire by subject matter experts, media experts, and student responses. Subject matter experts assess content, presentation, language, and constructivism, while media experts assess quality and design. Student response questionnaires cover appearance, presentation, graphics, and product benefits. The following table outlines the evaluation criteria categories as a guideline for assessing the product to be developed.

**Table. 1** Ideal Assessment Category Criteria

| No | Score range (*i*) Quantitative | Qualitative Categories |
|---|---|---|
| 1. | $\bar{X} > \bar{X}_i + 1{,}8\ SB$ | Very Good |
| 2. | $\bar{X}_i + 0{,}6\ SB < \bar{X} \leq \bar{X}_i + 1{,}8\ SB$ | Good |
| 3. | $\bar{X}_i - 0{,}6\ SB < \bar{X} \leq \bar{X}_i + 0{,}6SB$ | Pair |
| 4. | $\bar{X}_i - 1{,}8\ SB < \bar{X} \leq \bar{X}_i - 0{,}6\ SB$ | Poor |
| 5. | $\bar{X} \leq \bar{X}_i 1{,}8\ SB$ | Very poor |

Source: (Sukarjo, 2006)

Description:

$\bar{X}$ = validity score

$\bar{X}_i$ = ideal average value

$\bar{X}_i = \frac{1}{2}$ (ideal maximum score + ideal minimum)

$SB = \frac{1}{6}$ (ideal maximum score - ideal minimum)

ideal maximum score $=$
$\sum criteria\ item \times highest\ score$

$ideal\ minimum\ score =$
$\sum criteria\ item \times slowest\ score$

This study was conducted at SMP Muhammadiyah 1 Godean in Grade VIII. *e*-LKPD is considered feasible if the average score from media expert validators, material, and student responses is at least in the good category.

## 3. Result and Discussion

This study produced a learning media in the form of Liveworksheets-assisted mathematics e-LKPD on the material of Two Variable Linear Equation Systems with a constructivist approach for junior high school grade VIII. This research and development used five stages of the ADDIE development model, namely *Analyse-Design-Development Implementation-Evaluation.* The data from the trial on each research and development procedure are as follows.

### 3.1. *Analyze*

At the analysis stage, researchers conduct preliminary planning, which includes identifying products that are suitable for the needs of students, analysing learning materials and media, and analysing the curriculum used.

a. Material Needs Analysis

Material needs analysis was conducted to determine the material to be developed. Based on interviews with mathematics teachers at Muhammadiyah 1 Godean Junior High School, the material on Two Variable Linear Equation Systems (SPLDV) was considered difficult to teach because it was abstract and lacked real-life examples, and there were many methods of solution that students needed to understand. The survey results indicate that 16.7% found the material very difficult, 37.5%

found it difficult, 37.5% found it moderately difficult, 8.3% found it easy, and 0% found it very easy. This information is presented in the followimg diagram.

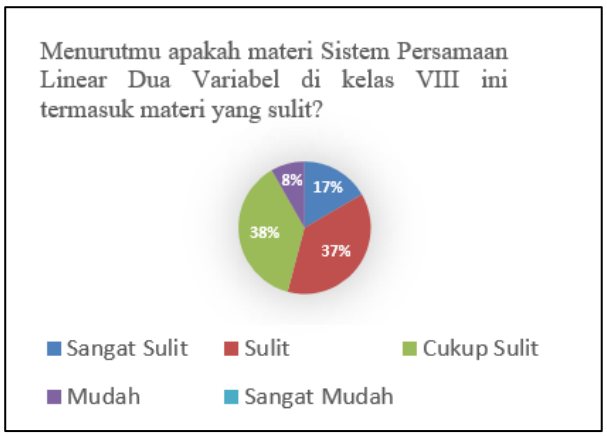


**Figure 1.** Material Difficulty Diagram

Based on the results of the analysis of learning material needs, it can be concluded that SPLDV is difficult material to convey to students because they have difficulty understanding the abstract nature of SPLDV material**.**

b. Media Needs Analysis

A needs analysis was conducted through interviews with mathematics teachers and the distribution of questionnaires to students in class VIII-D at SMP Muhammadiyah 1 Godean. The results showed that the school requires innovative and specific learning media, as the media currently used are still simple. Teachers considered *e*-LKPD suitable for use, especially in online learning. A total of 71% of students agreed that e-LKPD media could help the learning process, and 21% of students agreed with the development of e-LKPD to support online learning. This information is shown in the following diagram:

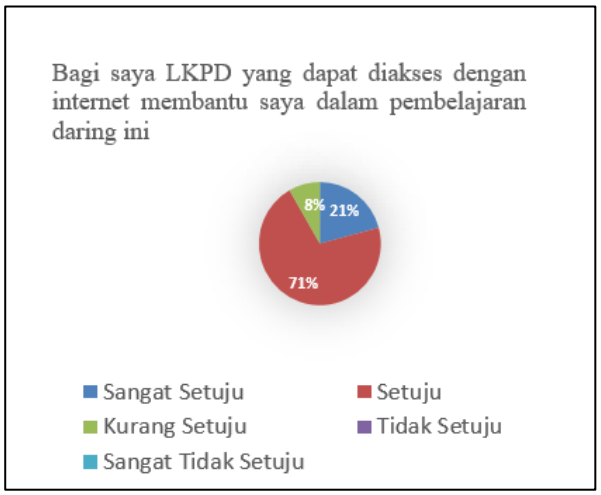


**Figure 2.** Learning Media Needs Diagram

c. Curriculum Needs Analysis

The curriculum needs analysis conducted by the researcher included an analysis of the subject matter, learning outcomes, and learning objectives that must be achieved by students. The results obtained are as follows:

1) Learning Outcomes

At the end of phase D, students are able to solve two-variable linear equation systems through several methods of problem solving.

2) Learning Objectives

Students being able to understand the Two Variable Linear Equation System and know the meaning of its solution, solve SPLDV using the elimination, substitution, and mixed methods, and be able to solve everyday problems related to the Two Variable Linear Equation System.

d. Needs Analysis of Learning Approach Models

An analysis of learning model requirements was conducted to determine the approach that best suited the material, objectives, and needs of the students. The model selected for the SPLDV e-LKPD was constructivism, as it encourages students to construct new knowledge based on previous experiences, such as understanding single-variable linear equations and systems of two-variable linear equations. In addition, this model is student-centred.

### 3.2. *Design*

At this stage, researchers collected information and images relevant to the theme to support the development of the *e*-LKPD. The main references were textbooks and workbooks for Grade VIII mathematics, as well as teacher's books. The elements of the *e*-LKPD include an introduction, table of contents, instructions, foreword, KI, KD, IPK, learning objectives, materials, sample questions, and exercises. The researchers also developed assessment instruments in the form of grids and questionnaires consisting of material experts, media experts, and student responses, which were validated by expert lecturers before use.

### 3.3. Development

After conducting product analysis and design, the next stage in the ADDIE development model is *Development*. At this stage, development or creation is carried out based on the results of the design of *e*-LKPD

mathematics assisted by Liveworksheets using a constructivist approach to SPLDV material for Grade VIII junior high school students.

a. Developing Product

First stage of developing Liveworksheets-assisted e-LKPD began with compiling SPLDV material and designing attractive layouts using Microsoft Word, limited to a maximum of nine pages per document and 5 MB in size, then converting them to PDF format. The next stage was to create teacher accounts on Liverworksheets, import the PDF files, and make them interactive using the 'make interactive worksheets' feature. ngembangan *e*-LKPD berbantuan Liveworksheets.

In the electronic worksheet developed using Liveworksheets, there are four types of questions used to increase interactivity. First, short fill-in questions are used to fill in student information such as name, student ID number, and class. Second, drop-down questions allow students to choose answers from several options. Third, join arrow or matching questions. These four types of questions are designed to make the learning process more interesting and encourage active student participation.

After coding is complete, the document is saved and named. The seven *worksheets* created are collected into one *workbook* using the *make interactive workbooks* feature, then a cover designed using *Canva* is added. Next, the researchers created two groups in Liveworksheets: one for validation (by subject matter experts, media experts, and teachers) and one for student trials. Groups are created through the *My Students* menu, then workbooks are added through *Assign Workbooks*. Class codes are shared with validators and test participants.

The first electronic worksheet products include: cover, development team, foreword, user guide, table of contents, syllabus, SPLDV concept map, materials, sample questions, exercises, bibliography, and author biographies.

b. Validation

At this stage, the *e*-LKPD that had been created was then given to experts or validators to be validated through a validation questionnaire. The experts in this study were two mathematics education lecturers and one mathematics teacher. The results of the validation by each validator can be seen in the following table

**Table 2.** Result of the Expert Validation Questionnaire

| Validator | Indicator Aspects | Score | Total Score |
|---|---|---|---|
| Expert Material 1 | Content | 36 | 103 |
| | Presentation | 35 | |
| | Language | 20 | |
| | Constructivism Approach | 12 | |
| Expert Material 2 | Content | 44 | 117 |
| | Presentation | 38 | |
| | Language | 21 | |
| | Constructivism Approach | 14 | |
| Total Score | | | 220 |
| Average Score | | | 110 |
| Assessment Criteria | | | Very Good |

Based on the expert material assessment table, the average calculation result is $\bar{X}$ =110, which is greater than 104.88. Therefore, the *E*-LKPD using the constructivist approach assisted by *Liveworksheets* on the material of two-variable linear equation systems for Grade VIII is classified as very good.

**Table 3.** Result of the Media Expert Validation Questionnaire

| Validator | Indicator Aspects | Score | Total Score |
|---|---|---|---|
| Media Expert 1 | Graphics Quality | 40 | 78 |
| | Display Design | 38 | |
| Media Expert 2 | Graphics Quality | 53 | 100 |
| | Display Design | 47 | |
| Total Score | | | 178 |
| Average Score | | | 89 |
| Assessment Criteria | | | Very Good |

Based on the media expert assessment table, the average questionnaire score is $\bar{X}$ = 89 but then 89 > 88.2, sehing so that electronic worksheet with a constructivist approach assisted by *Liveworksheets* on two-variable linear equation systems for Grade VIII meets the criteria for very good. Meanwhile, comments and suggestions from experts that need to be addressed for improvement are as follows.

1) Add a notation before writin a symbol at the beginning of a sentence

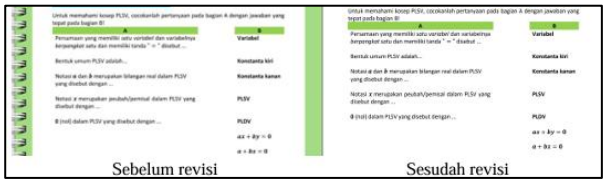


**Figure 3.** Addition of Notation Words

2) Madjust the question into a linear equation with one variable

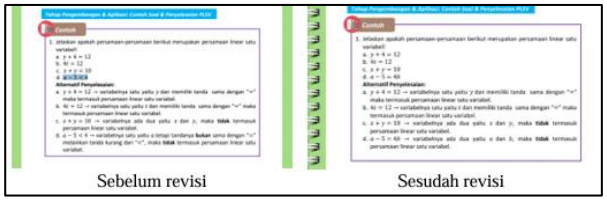


**Figure 4.** Improvement of Equation Form

3) Use of the words solution or completion

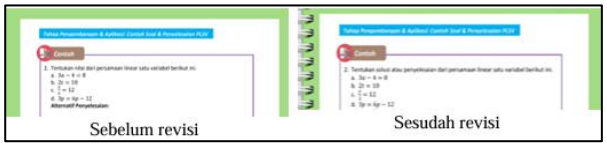


**Figure 5.** The Use of the Words Solution or Completion

4) Correcting the writing and clarify references

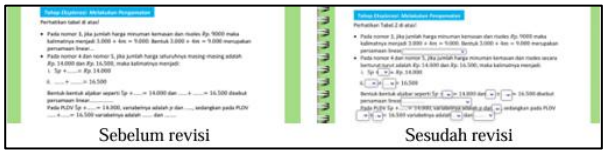


**Figure 6.** Table Numbering

5) Clarify the sentence by mentioning the name of the object referred into the example question

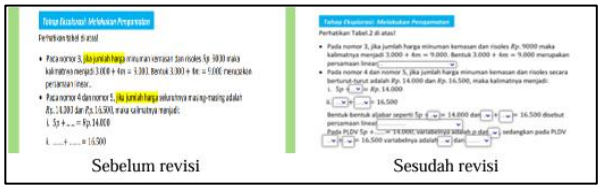


**Figure 7.** Explanation of Object Names

6) Replace word “karena” with “agar” to make it more appropriate to the context of the sentence.

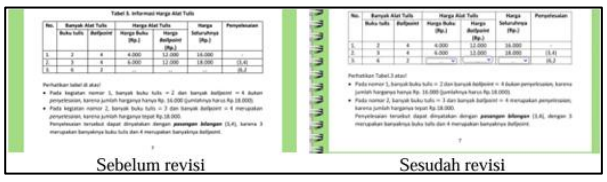


**Figure 8.** Adjusting Words to Snetences

7) Correct the definition of two variable linear equation system

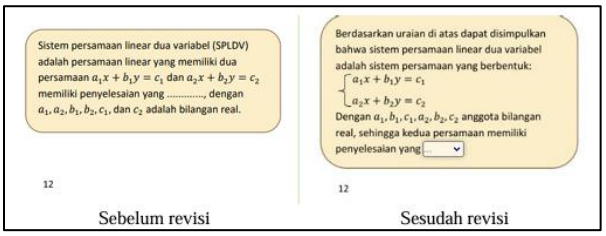


**Figure 9.** Correct the Definition

8) Explanation of correct and incorrest sentences in two variable linear equation system


**Figure 10.** Explation of correct and incorrect sentences

9) Correcting several incorrect words

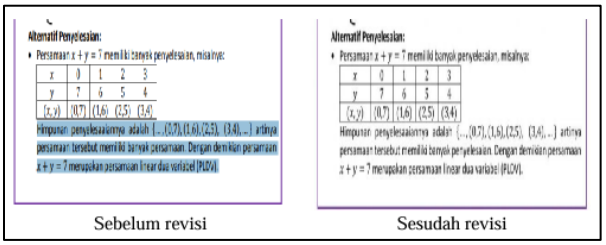


**Figure 11**. Word Correction

10) Correst sentences related to mathematical models.

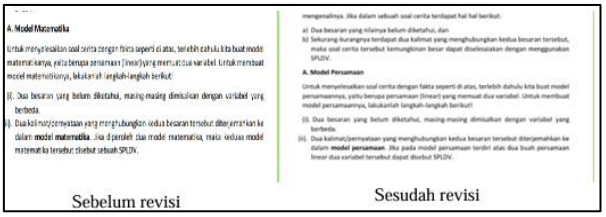


**Figure 12.** Word Correction

11) Correcting ambiguous sentences.

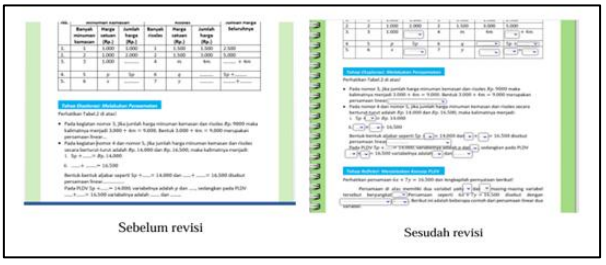


**Figure 13.** Word Correction

### 3.4. *Implementation*

After the worksheet has been declared feasible by experts based on the results of the validation questionnaire and improvements, the next stage is to implement or test the electronic worksheet product and distribute response questionnaires to participants to find out their

responses or feedback on the feasibility of the developed electronic worksheet.

The trial was conducted on elementary school students consisting of 10 students and a large class trial consisting of 24 students from class VIII-D of Muhammadiyah 1 Godean Junior High School. The results obtained from the student response questionnaire based on the aspects of appearance, presentation, graphics, and benefits of the product that had been distributed can be seen in the following table.

**Table 4.** Result of Students Response Score Calculation

| No | Assessment | Average Score | Qualitative Categories |
|---|---|---|---|
| **1.** | Small-scale trial | 97.7 | Good |
| **2.** | Large-scale trial | 96.6 | Good |

Based on the table 4 of studentsresponse scores, the average small class trial is $\bar{X} = 97.7$ then$109.14 < 97.7 \leq 88.38$. Meanwhile the average large class trial is $\bar{X} = 96.6$ then $109.14 < 96.6 \leq 88.38$, so that *E*-LKPD with a constructivist approach assisted by *Liveworksheets* on two-variable linear equation systems for Grade VIII based on trials is classified as good.

### 3.5. *Evaluation*

The evaluation stage is the final stage in the ADDIE development model. At this stage, the results of the product trial in the form of *e*-LKPD mathematics assisted by *Liveworksheets* with a constructivist approach to SPLDV material for grade VIII junior high school students are analysed. The *evaluation* stage is carried out to improve the e-LKPD that has been assessed by validators and student responses. Following this, final revisions are made based on feedback from validators and student responses. Based on the validation results from media and content experts, several recommendations were made regarding the developed product before conducting the pilot test with students. Subsequently, revisions were made based on validator feedback, ensuring the developed product falls into the 'good' or 'acceptable' category for testing. After being deemed acceptable, the next stage was a small-scale classroom trial conducted offline with 10 eighth-grade students from Class VIII-D at Muhammadiyah 1 Godean Junior High School. At this stage, no critical comments or suggestions regarding the product were received, so no revisions were made. Following that, a large-scale trial was conducted. During the large-scale trial, students were asked to evaluate the developed electronic worksheet by completing a questionnaire provided via Google Forms. The results of the large-scale trial indicated that the product falls into the 'good'

### 3.6. *Constructivism Approach in Electronic Worksheet*

This Study applies a constructivist approach in the development of Electronic Student Workbooks to facilitate students' understanding of Two-Variable Linear Equation Systems (SPLDV) at SMP Muhammadiyah 1 Godean, Yogyakarta. Through contextual exploratory activities, self-reflection, interactive visualizations, and teacher scaffolding, students are guided to construct knowledge actively, in line with social constructivist theories proposed by Vygotsky and Piaget (Shabani, 2010). This aligns with Koohang et al. (2011), who emphasize a learner-centered model in digital learning environments that includes collaboration, reflection, and self-assessment. The results from pretest and posttest of 24 students show an increase in average understanding scores from 52.6 to 82.1, representing a 56.1% improvement. These findings support the hypothesis that constructivist-based electronic student workbook are effective in enhancing conceptual understanding. Herianto & Lestari (2021) also found that interactive electronic teaching materials based on constructivist theory increase student engagement and enable them to build knowledge independently through group discussions and scaffolded guidance from teachers. Discussion of these results shows that the electronic student workbook integrates three main elements of Constructivist Learning Environments (CLE): pedagogical (authentic problems and real contexts), social (discussions and peer feedback), and technological (visualization and interactive simulations), as outlined by Wang (2009). The electronic student workbook allows students to observe graphs and tables related to SPLDV and relate them to real-life situations, enhancing the use of multiple representations, which is a key strategy in technology-supported mathematics learning. However, this study also highlights challenges such as cognitive overload if exploration is not supported with adequate scaffolding, as emphasized by cognitive load theory. Upu (2021) argue that while constructivism is effective, its success depends on structured learning design that balances free exploration with guided instruction.

## 4. Conclusion

The development research of e-LKPD mathematics assisted by Liveworksheets on the material of Two Variable Linear Equation Systems with a constructivist approach at SMP Muhammadiyah 1 Godean shows that the e-LKPD

is suitable for use in the learning process, with a very good category from subject matter and media experts, as well as a good category from student responses. However, this study only cover feasibility without effectiveness stage. This study did not do the test to determine whether the use of worksheet could improve student learning outcomes. Hopefully next study will conduct an implementing post test to examine the effectiveness of the developed worksheet.

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