Development of live worksheets-assisted discovery learning materials on two-variable linear equation systems

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Abstract

The fast development of technology contributes significantly to education and the production of quality and sustainable human resources. The application of technology in learning is critical to achieving learning objectives and improving student learning outcomes. One of the things that can be used from technology is the creation of learner work exercises in learning. This study aims to determine the validity, practicality, and effectiveness of discovery learning-based student worksheets assisted by live worksheets on the material of the linear equations of a variables system. The type of research used is the Borg and Gall research and development model, consisting of research and initial data collection, planning, development of initial product formats, initial trials, product revisions, field trials, product revisions, field tests, final product revisions, dissemination, and implementation. The instruments used in the research are observation, interviews, questionnaire distribution, tests, and documentation. The results of the research with the development of discovery learning-based student worksheets assisted by live worksheets on the material of the system of linear equations of two variables, among others: (1) the average percentage of validity of student worksheets in terms of language, material and media is 74% with valid criteria, (2) the average percentage of practicality of student worksheets based on teacher and student responses is 86% with very practical criteria, (3) while the average value of learning outcomes in the effectiveness test of student worksheets based on tests conducted is 84 with a percentage of completeness of 87% including a very effective category.

Keywords: Learner worksheets, Discovery learning, Live worksheets and two-variable linear equation system

INTRODUCTION

Learning is an educational process that provides opportunities for students to develop potential in aspects of attitudes, knowledge and skills that can be used in national and state life with the aim of contributing to the welfare of human life (Arimurti et al., 2019). Education plays a strategic role in society because the progress and decline of the quality of societal civilization depends on the quality of education implemented in that place (Rubowo et al., 2019). Learning is closely related to science, one of the important knowledge areas that students have is mathematics. Mathematics is one of the important subjects and is very useful in

everyday life because all aspects encountered in life are close to mathematics (Musdi & Ahmad Fauzi, 2019).

Mathematics is a universal science that underlies the development of modern technology in various scientific disciplines and is able to develop human thinking power (Nursyeli & Puspitasari, 2021). Mathematics is one of the subjects taught at every level of education from elementary school to university, so it needs to be taught and functioned optimally as a forum for developing intelligence, understanding, skills and abilities (Yuniati, 2019). The learning outcomes obtained by students are one of the benchmarks in analyzing a subject. The mathematics learning outcomes of students in Indonesia can be said to be still low, this is proven by the results of TIMSS (Trend in International Mathematic and Science Study) In 2003 Indonesia was ranked 35th out of 50 countries, in 2007 Indonesia was ranked 36th out of 49 countries, in 2011 Indonesia was ranked 38th out of 42 countries and in 2015 Indonesia was ranked 32nd out of 49 countries while in 2019 Indonesia was ranked 46th out of 51 countries (Surur et al., 2019). Judging from the results of several editions of the year, mathematics in Indonesia needs to be taken seriously with the aim of improving students' understanding of mathematics.

The role of teachers in improving understanding and solving mathematical problems is considered very important because they deal with and convey material directly to students (Surur et al., 2019). As is known, the 21st century is known as the era of globalization and teachers should try and continue to learn to become teachers with standards and able to adapt to the demands of the times. One example of a standard teacher is being able to utilize various innovations in ICT (Information and Communication Technologies) (Lestari, 2019). For this reason, there is a need for innovation in the learning process, skills in delivery and time management of learning activities so that students can be active and creative in the learning process.

Good mastery of mathematics is not only important to support students' academic success, but is also needed to prepare students to live their lives in society or in real life. One branch of mathematics that is closely related to real world life is the system of linear equations in two variables. However, many students experience difficulties in learning systems of linear equations in two variables especially in contextual problem-solving studies (Dwi Amalia & Mustofa Lestyanto, 2021). This is reinforced by the research results of Yuni Susanti and Djarot Friansah which show that many students do not master the concept of systems of linear equations in two variables because learning activities focus on memorizing formulas and do not

emphasize understanding concepts so that students are unable to solve problems related to the material (Yuni Susanti, 2019).

With the current increase in technology, this is a demand of the times so that the nation's next generation is ready to face the era of globalization. The application of technology in learning is very important to achieve learning goals and improve learning outcomes. One thing that can be utilized from technology is the creation of Student Job Training. Student Job Training is a guide for students to learn a concept so that students can solve the problem (Khikmiyah, n.d. 2019). Meanwhile, according to Viktor Bombang student worksheets is teaching material that is presented systematically in accordance with the objectives achieved in learning in image format, explanation of material and problem questions, student worksheets can be used in all subjects and all levels of education (Bombang et al., n.d. 2022).

Student worksheets can increase students' cognitive level and make learning more interesting (Arsyad, 2003). Using student worksheets in learning has many benefits, including being able to develop creativity because students can directly explore the knowledge they have. The next benefit is helping students understand the material provided because the students worksheets contains explanations of the material and questions for students' understanding (Badriyah, 2023).

The student worksheets developed by researchers in this research meets the qualifications. Firstly, it is based on the independent curriculum with provisions that refer to learning outcomes and criteria for achieving learning objectives contained in the independent curriculum. Second, supporting active and meaningful learning so as to encourage active students to understand the learning material in depth. Third, it is oriented towards higher order thinking skills (HOTS) so that it requires students to think critically and creatively in solving problems. Fourth, according to the students' abilities, so that in making the students worksheets, the researcher adjust it to the students' abilities obtained from data obtained from the subject teacher. Fifth, design and design the student worksheets in an interesting way so that it motivates students in the learning process. By paying attention to the qualifications for making and designing, it is hoped that the resulting student worksheets can be a good learning resource for students, help students understand the learning material and develop understanding and creativity and become reference material for making it for subject teachers (Batubara, 2021).

Discovery Learning is student-centered learning. Discovery learning or discovery learning is an approach to the learning process where students are activated to discover and understand their own concepts or knowledge through direct experience (Maulana Arafat Lubis,

2022). This approach places emphasis on active student engagement, exploration, and problem solving as a way to build deep understanding. The relationship between student worksheets and Discovery Learning lies in the work steps that will be developed in accordance with the discovery learning syntax, so as to help students understand the teaching material provided and hone their problem-solving abilities in the hope of achieving the lesson objectives presented.

Live Worksheets is an online learning platform or interactive worksheet creation tool that allows teachers and students to interact directly with learning material (Nurlaila et al., 2022). Live Worksheet is defined as an application that can be used to create interactive student materials and worksheets online. Live worksheets is one digital learning media that can be used to support learning Discovery Learning which will be developed by researchers. The use of live worksheets in learning is one step in combining technology and learning with the aim that students can discuss or relearn the material provided independently through live worksheets created by researchers according to the circumstances and abilities of students at the school.

RESEARCH METHODS

The type of research that will be carried out is development research (Research and Development). Development research is an activity of collecting, processing, analyzing and presenting data carried out systematically and objectively accompanied by activities to develop a product to solve the problems faced (Rangkuti, 2016). Research and Information Collecting, this stage is also called the pre-development planning stage or thinking about new products to be developed. There are four analysis steps developed in product development, namely needs analysis, learning material analysis and formulation of learning objectives.

Planning, Researchers create student worksheet designs according to the solution needs of the analysis stage. The designed student worksheet contains instructions for using it, materials, assignments and work steps that are adjusted to the syntax discovery learning. The material used is the Two Variable Linear Equation System material. Student worksheet is also adjusted to the indicators of achievement of the independent curriculum mathematics competency by being developed in the form of a link that can be accessed on computers, laptops, smartphones and can also be printed according to needs. develop preliminary form of product, at this stage, researchers conduct product development with the aim of producing a final product. The product results are in the form of student worksheets based on Discovery Learning in the form of a link that can be printed or accessed directly via computer, laptop and smartphone. After the research product is developed, the researcher validates the student

worksheet to determine the validity of the product or is called expert appraisal. Assessment instruments are used to obtain data and input from experts or content, language and media validators.

Preliminary Field Testing, at this stage is done initial field trials on a limited scale. involving 6-12 subjects. Data collection and analysis can be done by distributing the product.The researcher conducted a limited trial on 6 students of class VIII-B to test the initial practicality of product development. If the results of the limited trial indicate that there are some difficulties in using student worksheet, then the researcher revises it to overcome these difficulties. Main Product Revision, after validation and initial trials, revisions are obtained, then the researcher revises or corrects the deficiencies obtained from qualitative information about the product being developed so that the product being developed is ready for the next stage.

Main Field Testing, at this stage, the researcher implemented the student worksheet product involving class VIII-B with 15 students to evaluate and analyze students' mathematical understanding using a practical questionnaire, so as to obtain more in-depth information about students' mathematical understanding using student worksheet based on discovery learning. Operational Product Revision, at this stage, researchers make improvements/refinements to the results of the field trial, so that the product developed is an operational model design that is ready to use. The results of the field trial involve a larger group than the previous test with the aim of determining the success of the product in achieving goals and collecting information.

Operational Field Testing, after revisions were made in the previous stage, at this stage the researcher implemented the product and distributed questionnaires to all students in class VIII-A with the aim of analyzing students' understanding of the student worksheet that had been developed. At this stage, the researcher also assessed the student worksheet through the effectiveness and practicality tests conducted previously. The effectiveness of the student worksheet is seen from the results of students' understanding in working on the final questions of the material on the system of linear equations in two variables. While the practicality of the student worksheet is seen from the results of the distribution of questionnaire sheets given to teachers and students.

Final Product Revision, this stage makes final improvements to the product developed based on field tests conducted by researchers to produce the final product. Dissemination and Implementation, this level refers to the dissemination of research results to relevant communities, including researchers, practitioners, policy makers, and the general public. The

purpose of dissemination is to ensure that research findings are accessible and utilized by interested parties. Implementation is the process of applying research findings or recommendations into appropriate practices or policies. However, in the research to be conducted, this stage was not carried out due to the time constraints of the researcher. The type of data that will be used in this research is quantitative and qualitative data. Quantitative data is collected from the results of validation scores, observations, questionnaires and student learning outcomes, while the qualitative data is analyzed to determine product validity, practicality and effectiveness of the student worksheets that will be applied.

This development research procedure uses a research model developed by Borg and Gall in 1983, namely ten-step development research. The reason researchers use the Borg and Gall development research model is that it can produce products that can be accounted for, thereby providing opportunities for continuous evaluation and revision through the stages that researchers will go through.

The research procedures carried out are research and information collecting, planning, develop preliminary form of product, preliminary field testing, main product revision, main field testing, operational product revision, operational field testing, final product revision, dissemination and implementation (Rangkuti, 2016). However, the dissemination and implementation step was not carried out by the researcher and is one of thelimitations in this study. The distribution of this product should be carried out on a large scale so that the impact of this product is more widely realized, but due to limited manpower, time and costs, the distribution of this student worksheet was only carried out in certain schools.

This research was carried out in class VIII MTs S GUPPI Malintang, Bukit Malintang District, Mandailing Natal Regency, North Sumatra Province from December 2023 to June 2024 (7 months) of the 2023/2024 academic year. Class VIII at the school has 2 study groups with class VIII-A having 30 students and class VIII-B having 20 students.

Research instruments are tools that can be used to collect research data, and are also called research techniques. The data collection instruments that will be used in this research are (1) product validation sheets consisting of material, language and media validation. (2) product practicality sheet consisting of teacher responses and student responses. (3) effectiveness test sheet to improve discovery learning learners. The research instrument was validated by UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan, Institut Pendidikan Tapanuli Selatan, Universitas Graha Nusantara (UGN) Padangsidimpuan and mathematics academics from South Tapanuli Regency.

Data collection techniques in research are (1) Observation in this research serves to observe needs and other important things that need to be improved as a basic ingredient for developing a product. Interviews are used as a data collection method when researchers conduct initial research and stages in developing research products. The interviews conducted were unstructured interviews, in other words the researcher did not use an interview guide with the aim of obtaining as deep and broad information as possible. (2) The questionnaire is used to validate the product being developed including validation of material, media and language. Apart from that, the questionnaire was also used to analyze the practicality of the product being developed, including teacher and student responses. The questionnaire contains statements regarding the product being designed and developed. Apart from containing statements, the questionnaire also contains criticism and suggestions for improvement. Material, language and media validation questionnaires are given to experts in their respective fields with minimum master's qualifications who are experienced in product development. According to Riduwan, the validity criteria can be seen in Table 1. (Hamdunah, 2015)

Table 1. Product Validity Criteria

Percentage of Achievement	Interpretation
$v \geq 75\%$	Very Valid
$67\% \leq v < 75\%$	Valid
$40\% \leq v < 67\%$	Fairy Valid
$v < 40\%$	Invalid

Meanwhile, according to Riduwan, the practicality criteria for the product being developed can be seen in Table 2. (Hamdunah, 2015)

Table 2. Product Practicality Criteria

Percentage of Achievement	Interpretation
$p \geq 75\%$	Very Practical
$67\% \leq p < 75\%$	Practical
$40\% \leq p < 66\%$	Fairy Practical
$p < 40\%$	Not Practical

(3) The test is given to measure how far the results obtained by students after using the student worksheets that have been designed, the test given is a subjective test, generally the subjective test is in the form of an essay or description. A description test is a written form

whose composition consists of question items that contain problems and require students to answer through word descriptions that reflect students' thinking abilities. The tests given have previously been tested for validity, reliability, level of difficulty and distinguishing power of the questions.

The test is given in two stages, namely pre-test and post-test, the assessment of the tests given is based on stages discovery learning includes giving stimulation, problem statement, data collection, data processing and verification. Then data pre-test and post-test the collected data is analyzed using the following formula.

$$\text{N} - \text{Gain} = \frac{\text{postest score} - \text{pretest score}}{\text{max score} - \text{pretest score}}$$

The results of the analysis from above obtained values N-gain and classified according to Table 3.

Tabel 3. Normalized Gain Classification (N-Gain)

N-Gain Score	Criteria
$\text{N} - \text{Gain} > 0{,}7$	High
$0{,}3 \leq \text{N} - \text{Gain} \leq 0{,}7$	Currently
$\text{N} - \text{Gain} < 0{,}3$	Low

RESULTS AND DISCUSSION

This section presents the results of research on the development of student-based worksheets discovery learning help live worksheets which refers to the Borg and Gall development model with a 10 steps model. Student worksheets were declared suitable for use based on validation carried out by researchers, namely material validation, language validation and media validation.

Meanwhile, to test the practicality of the product developed, the researchers distributed response questionnaires to mathematics subject teachers at the school and to students as material for evaluating the product. Meanwhile, the effectiveness of the product developed by the researcher provides a question sheet to students as a comparison material to determine whether the product is successful or useful for users. The following is a description of the worksheet product that has been tested.
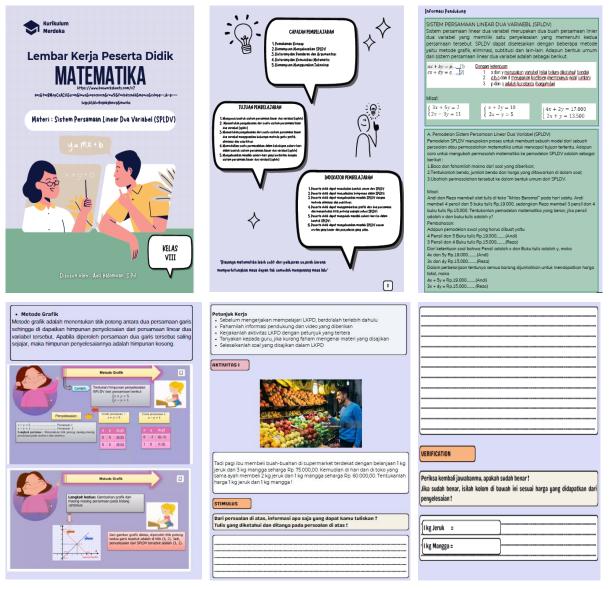
Figure 1. Example of Worsheet Product

A good product is a product that has gone through several stages of testing and revision with the aim of getting maximum results. In validating learning products, researchers must go through several research steps, namely research and gathering initial information, planning and developing the initial product format. There are three parts that are validated by the validator, namely language, material and media validation. To validate the product, researchers chose validators who are qualified in their respective fields and work as lecturers at various universities in Padangsidimpuan.

Table 4. The Product of Validator

No	Part of Validation	Validator (Initial)	Univercity
1	Material	SDH	IPTS Padangsidimpuan
		WAR	Pemerintah Kab. Tapanuli Selatan
2	Language	EI	UIN Syekh Ali Hasan Ahmad Addary
		AA	Padangsidimpuan
3	Media	AM	UGN Padangsidimpuan
		HLS	IPTS Padangsidimpuan

The results of validation in the language field by EI and AA average percentage of 80% with very valid criteria. Then validate the material field by SDH and WAR had an average percentage of 72% with valid criteria, while validation in the media sector by AM and HLS had an average percentage of 71% with the valid category. Based on the results of validation tests in the fields of language, materials and media including 6 validators from various agencies, the average percentage was obtained 74 % with criteria Valid, from the results of developing student worksheets based discovery learning help live worksheets on the material of two variable linear equation systems by comparing it with the theory put forward by Hadi, it can be declared suitable for use because the product is within the valid range (Hadi et al., 2020).

After conducting a field test involving the research targets, namely all students in class VIII-A MTs S GUPPI Malintang and 2 mathematics subject teachers, the researcher carried out a practicality and effectiveness analysis with the aim of whether the product developed by the researcher was feasible, easy and good to use in learning.

Practicality is something that can make it easier for people to use so that there is a feeling of enjoyment in using it. The student worksheets applied to the learning process are valid worksheets and have gone through several stages in product improvement. The practicality referred to in this product is how teachers and students as the main actors in education are able to use the product easily and without facing many obstacles. The practicality test in this research was carried out by distributing questionnaires responding to teachers and students as users of the products being developed.

Based on the results of distributing response questionnaires to 2 mathematics teachers, the development of student worksheets is based on discovery learning help live worksheets in the material system of linear equations in two variables obtained an average percentage value of 86 % with criteria Very Practical. This shows that the student worksheets designed and developed by researchers are able to provide convenience to teachers so that they help teachers in conveying material and understanding students (Nababan, 2020).

The distribution of the student response questionnaire was carried out after the worksheet designed and developed by the researcher was distributed and used by students in class VIII-A MTs S GUPPI Malintang, totaling 30 students. The results of the practicality of the product developed by researchers are student worksheets based of discovery learning help live worksheets in the material system of linear equations in two variables obtains the average 0,86 and percentage 86 % by category Very Practical.

Thus, the development of student worksheets is based on discovery learning help live worksheets the material on systems of linear equations in two variables is stated to be very practical and can be used by teachers and students. The results of this research show harmony with the theory presented by Van Den Akker that "practically refers to the extends that user or other experts consider the intervention as appealing and usable in normal conditions" with the meaning of practicality refers to the extent to which the product produced is attractive and easy to use by users in normal situations (Jan van den Akker, 2013)

Based on the results of research conducted on class VIII-A MTs S GUPPI Malintang, there was a significant difference in initial learning results (pretest) and final learning results (posttest). The minimum completeness criteria used at this school for exact subjects is 75, so researchers use the minimum completeness criteria to measure student learning outcomes. The initial results (pretest) obtained before learning to use the product being developed were average 60 with a completion percentage 30 %. Meanwhile, the final results (posttest) or after learning to use the product being developed are average 84 with a completion percentage 87 %. According to Sarwoedi, effective criteria in analyzing learning outcomes are learning completeness, including the criteria for being very effective and effective with a percentage range (Dwi Amalia & Mustofa Lestyanto, 2021). Based on this theory, there was a significant increase in completeness in the class studied where the percentage of completeness obtained was 87% in the very effective category. Thus, the development of student worksheets is based on discovery learning help live worksheets the material on systems of linear equations in two variables is said to have a very good impact in use because the product is in the range of being very effective in use. According to Latif, the effectiveness of a product can be seen from the extent to which learning outcomes increase after users apply the product. Based on the analysis data made by researchers it explains that the product developed can improve learning outcomes in the range of 0.61 with a percentage of 61% and is included in the medium category. The difference in the results obtained by researchers compared to previous studies lies in the

percentage of the feasibility of the product developed, even though the product tested was already suitable for use.

CONCLUSION

Based on the results obtained at the initial product development stage, distribution of response questionnaires and distribution of tests carried out, researchers can conclude several things, namely: (1) Student worksheet based discovery learning help live worksheets The two variable linear equation system material is said to be suitable for use in terms of language, material and media with an average percentage obtained of 74% and valid criteria. (2) Student worksheets-based discovery learning help live worksheets the material on systems of linear equations in two variables is said to be easy to use based on a response questionnaire from 2 subject teachers and 30 students with an average percentage of 86% and very practical criteria. (3) Student worksheets-based discovery learning help live worksheets the two variable linear equation system material is said to have a good impact on students' understanding with an average score of 84 and a completion percentage of 87% in the very effective category.

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