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Development of Electronic Student Worksheets Based on the Discovery Learning Model on Algebra Material

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ABSTRACT. This study aims to assess the validity and practicality of electronic student worksheets (LKPD) based on the Discovery Learning model, using LiveWorksheets, for Algebraic Expressions in Grade VIII Junior High School students. The research follows a Research and Development (R&D) approach, employing the ADDIE development model, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. The study was conducted at SMP Muhammadiyah 6, Yogyakarta. Data were collected using expert validation instruments from subject-matter and media experts, as well as student response questionnaires. The findings reveal that the developed electronic worksheets were rated highly valid by subject matter experts (82.89%) and by media experts (94.48%). Regarding practicality, student assessments indicated 88% for small-group trials, categorized as very practical, and 79.82% for large-group trials, categorized as practical. These results indicate that the electronic worksheets are valid and practical for use in classroom instruction.

Keywords: algebra; discovery learning; electronic student worksheets; live worksheets

ABSTRAK. Penelitian ini bertujuan untuk mengevaluasi tingkat kevalidan dan kepraktisan penggunaan LKPD elektronik berbasis model pembelajaran *Discovery Learning* dengan memanfaatkan platform LiveWorksheets pada materi Bentuk Aljabar kelas VIII SMP. Metode yang digunakan adalah penelitian dan pengembangan (*Research and Development*) dengan mengacu pada model ADDIE yang terdiri dari lima tahap, yaitu: analisis, perancangan, pengembangan, implementasi, dan evaluasi. Lokasi penelitian ini adalah di SMP Muhammadiyah 6 Yogyakarta. Pengumpulan data dilakukan melalui instrumen penilaian dari ahli materi, ahli media, serta angket respons peserta didik. Hasil analisis menunjukkan bahwa LKPD elektronik yang dikembangkan mendapatkan predikat sangat valid dari penilaian ahli materi dengan persentase total 82,89%, dan juga dinilai sangat valid oleh ahli media dengan skor keseluruhan 94,48%. Sementara itu, aspek kepraktisan diperoleh melalui penilaian siswa, yang menunjukkan bahwa LKPD tergolong sangat praktis pada kelas kecil dengan skor 88%, dan praktis pada kelas besar dengan skor 79,82%. Berdasarkan temuan tersebut, dapat disimpulkan bahwa LKPD elektronik ini layak digunakan dalam kegiatan pembelajaran karena memenuhi kriteria valid dan praktis.

Kata kunci: aljabar; *discovery learning,* Elektronik Lembar Kerja Peserta Didik, *live worksheets*

INTRODUCTION

As time goes by, science continues to advance, driving the emergence of various technological innovations characteristic of the digital era. These developments have impacted various fields, including education (Lestari, 2018). The integration of technology in education is expected to support the learning process more optimally. This is reflected in the increasing number of educational institutions, including Muhammadiyah 6 Yogyakarta Junior High School, which have begun adopting information and communication technology in their teaching and learning

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activities. One use of this technology is Electronic Student Worksheets (E-LKPD). E-LKPD is a digital learning platform that contains materials and practice questions and can be accessed on devices such as mobile phones and computers. Compared to printed versions of LKPD, E-LKPD offers advantages in effectiveness, practicality, and interactivity. The interactive features in E-LKPD are believed to increase student engagement in learning and stimulate creativity and innovation (Agustinawati et al., 2024; Lathifah & Hidayati, 2021; Subakti et al., 2021). Therefore, learning becomes more enjoyable and helps overcome boredom, especially in subjects considered difficult, like mathematics.

One approach to overcoming this challenge is the Discovery Learning model. This model encourages students to actively discover and explore concepts independently. This results in a deeper understanding of the material. The main goal of Discovery Learning is to develop students' logical and critical thinking skills and to foster curiosity and active engagement in the learning process (Sayangan et al., 2024). In practice, teachers act as facilitators, guiding students in discovering learning concepts or procedures, with an emphasis on conceptual understanding.

One of the problems frequently encountered in mathematics learning is students' poor conceptual understanding (Giriansyah et al., 2023; Radiusman, 2020; Verina & Darhim, 2023). Conceptual understanding is a crucial component of mathematics because it serves as the foundation for students in solving problems in both academic and everyday contexts. Mathematics has a continuous structure, so mastery of prior concepts is crucial for understanding subsequent ones. One important topic in mathematics is algebra, which not only serves as a language in science but also as a foundation for mastering more complex topics at subsequent levels of education. Understanding algebra is also highly relevant in everyday life, as it trains logical and systematic thinking skills. However, some students find algebra difficult to understand (Saragih et al., 2025; Syarah et al., 2023; Wildani, 2018). This is due to difficulties in identifying variables and performing arithmetic operations on positive and negative numbers.

This situation was also found at SMP Muhammadiyah 6 Yogyakarta, particularly among eighth-grade students. Based on observations, algebra is one of the most challenging topics for students to understand. In addition to difficulties in understanding the concepts, the limited teaching materials available at the school, which rely solely on Merdeka curriculum textbooks, also hinder the learning process. This leads to a decline in student interest in mathematics. Teachers also emphasized the need for more innovative and engaging learning media to improve the quality of algebra learning. In this regard, the use of E-LKPD based on the Discovery Learning model is an appropriate alternative solution.

Previous research by Novitasari et al. (2021) found that the developed E-LKPD was valid, practical, and suitable as a learning medium. The resulting product received positive feedback from teachers and students and was effective in supporting the learning process. The strengths of this research lie in the development platform, the learning model, and the research context. Based on this background, the researcher is interested in developing an E-LKPD based on the Discovery Learning model for algebraic forms material to improve learning quality at SMP Muhammadiyah 6, Yogyakarta.

METHOD

This research uses the Research and Development (R&D) method, referring to the ADDIE development model, which consists of five main stages: Analyze, Design, Develop, Implement, and Evaluate. The R&D method aims to produce a learning product and test its effectiveness and feasibility (Fransisca et al., 2019). In the Analyze stage, researchers analyzed needs, student characteristics, and the curriculum—the needs analysis aimed to identify problems faced by educators and students in the learning process. Student analysis was conducted to identify diverse levels of ability and learning needs, allowing for the determination of appropriate learning outcomes. Meanwhile, the curriculum analysis ensured the suitability of the electronic student

worksheet development to the applicable curriculum at SMP Muhammadiyah 6 Yogyakarta, particularly in formulating learning outcomes and objectives. The Design stage includes developing ideas, content, and a learning media framework, as well as developing validation instruments for subject matter experts, media experts, and student response questionnaires. This stage lays the foundation for systematic, measurable product development. In the Develop stage, researchers develop materials based on the Learning Objective Flow (ATP) and develop media according to the initial design. Subject matter experts and media experts then validate the product to ensure the appropriateness of the content and presentation. The Implement stage involves piloting the developed learning media with students. The trials are conducted on two scales: small and large classes. Assessments are obtained through student response questionnaires, which are analyzed to assess the media's practicality. The final stage, Evaluate, involves evaluating the trial results. If weaknesses are found, researchers revise the media to optimize the resulting product and make it ready for use in learning.

The subjects in this study were 1) Material experts, namely lecturers of Mathematics Education at Ahmad Dahlan University and Mathematics teachers of SMP Muhammadiyah 6 Yogyakarta. 2) Media experts, namely lecturers of Mathematics Education at Ahmad Dahlan University in the field of media development, and Mathematics teachers of SMP Muhammadiyah 6, Yogyakarta. 3) Five students from class VIII B of SMP Muhammadiyah 6 Yogyakarta as a small class trial. 4) Students of class VIII B of SMP Muhammadiyah 6 Yogyakarta as a large class trial. The data analysis technique aims to measure the validity and practicality of the developed electronic LKPD. Validity is evaluated based on assessments from material experts and media experts. Data were collected in both qualitative and quantitative forms, including suggestions and input, as well as quantitative data obtained through assessment instruments using a specific scale. Media practicality was analyzed through student questionnaires, with the results processed descriptively using percentages. The assessment criteria used to determine the level of validity and practicality are shown in Table 1.

Table 1. Validity and Practicality Assessment Criteria

No	Range	Validity	Practicality
1	$80\% < X \leq 100\%$	Very Valid	Very Practical
2	$60\% < X \leq 80\%$	Valid	Practical
3	$40\% < X \leq 60\%$	Less Valid	Less Practical
4	$20\% < X \leq 40\%$	Not Valid	Not Practical
5	$0\% < X \leq 20\%$	Very Invalid	Very Impractical

Source: Modification by Riduwan (2016)

RESULTS AND DISCUSSION

In the initial stage, namely the analysis stage, the researcher analyzed the needs, student characteristics, and the applicable curriculum at SMP Muhammadiyah 6 Yogyakarta. The needs analysis was conducted through observations and interviews with mathematics teachers. The observations showed that students still had difficulty solving algebraic problems, especially story problems. Based on the interviews, the teacher reported that class VIII B students tended to get confused and make mistakes when working on problems that were not identical to the examples given. Students still needed guidance when working on context-based problems. In addition, the teaching materials were still in print, so the teacher felt the need for more engaging learning media to improve understanding of algebraic concepts. Based on these needs, the researcher developed an E-LKPD using the Discovery Learning model and the LiveWorksheets platform. Researchers also analyzed students through direct involvement in learning. This aimed to determine initial abilities, required learning outcomes, and technological readiness, such as smartphone ownership, to support the research. Curriculum analysis showed that SMP

Muhammadiyah 6 Yogyakarta, particularly class VIII B, had implemented the Independent Curriculum. Therefore, the learning outcomes and objectives used to develop the E-LKPD were aligned with this curriculum.

In the design stage, researchers began to design the learning media concept, including establishing learning outcomes and objectives. The results of the needs analysis served as the basis for developing media based on the Discovery Learning model for algebraic material using LiveWorksheets. Researchers compiled the material content based on the results of previous interviews and analysis, then designed the structure of the E-LKPD from the front cover to the closing page. Validation instruments for material experts, media experts, and student response questionnaires were also prepared at this stage. Images of the front and back covers are shown in Figure 1.

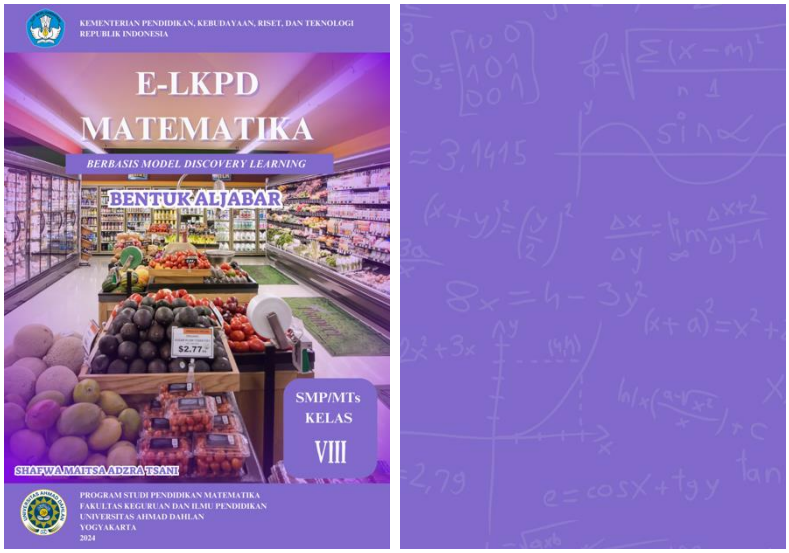

Figure 1. Front Cover and Back Cover Appearance

The next stage is Development. This stage is carried out by developing the previously designed media. The design of the media was first designed using Canva which was then converted into PDF format, then to make it into E-LKPD form it was entered on the liveworksheets website. Furthermore, before being used as teaching materials, the developed media was validated first until it could be declared valid in terms of technology and the preparation of materials in the E-LKPD. Analysis of material expert validity data was carried out to determine the validity of the material contained in the developed E-LKPD. The validity of the material was assessed by material experts consisting of validator 1, namely Mrs. Soffi Widyanesti Priwantoro, M.Sc. and validator 2, namely Mr. Hidayat Nursyawaludin, S.Pd. The results of the validation of solid material experts are seen in Table 2. Analysis of media expert validity data was carried out to determine the validity of the developed media. The validity of the media was assessed by media experts consisting of validator 1, namely Mr. Aan Hendroanto, M.Sc. and validator 2, namely Mr. Hidayat Nursyawaludin, S. Pd. The results of the validation by solid media experts are seen in Table 2.

Table 2. Overall Results of the Material Expert Validation Assessment

No	Material Expert	Percentage	Criteria
1	Material Expert 1	67, 11 %	Valid
2	Material Expert 2	98, 66 %	Very Valid
	Percentage Overall	82, 89 %	Very Valid

Based on Table 2, material expert one and material expert 2 obtained an overall accumulated average score of 82.89%, indicating a very valid result. This indicates that the material from the developed algebraic learning media met the criteria of being very valid.

Table 3. Overall Results of Media Expert Validation Assessment

No	Media Expert	Percentase	Criteria
1	Media Expert 1	94, 17 %	Very Valid
2	Media Expert 2	94, 79 %	Very Valid
	Percentage Overall	94, 48 %	Very Valid

Table 3 shows that Media Expert 1 and Media Expert 2 obtained an overall average cumulative score of 94.48%, categorized as very valid. This indicates that the liveworksheets teaching material falls within the very valid criteria.

In the Implementation stage, after validation, the learning media were implemented through a trial with students to assess the practicality of the E-LKPD. The trial was conducted in two stages: a small-scale and a large-scale stage. The small-scale trial involved five students in grade VIII B. The questionnaire results are shown in Table 4, with an average score of 88%, categorized as very practical. In the large-scale trial, all grade VIII B students completed the questionnaire. The results are shown in Table 5, with an average score of 79.82%, indicating practicality.

Table 4. Results of Small Class Trial

No	Name	Score	Percentage	Criteria
1	A	80	80 %	Very Practical
2	B	89	89 %	Very Practical
3	C	84	84 %	Very Practical
4	D	97	97 %	Very Practical
5	E	90	90 %	Very Practical
	Total Score		440	
	Average Percentage		88%	
	Criteria		Very Practical	

Table 5. Results of Large Class Trial

No	Name	Score	Percentage	Criteria
1	A	70	70%	Practical
2	B	82	82%	Very Practical
3	C	80	80%	Very Practical
4	D	80	80%	Very Practical
5	E	78	78%	Practical
6	F	68	68%	Practical
7	G	84	84%	Very Practical
8	H	72	72%	Practical
9	I	73	73%	Practical
10	J	91	91%	Very Practical
11	K	80	80%	Very Practical
12	L	91	91%	Very Practical
13	M	97	97%	Very Practical
14	N	75	75%	Practical
15	O	80	80%	Very Practical
16	P	69	69%	Practical
17	Q	75	75%	Practical
18	R	80	80%	Very Practical
19	S	94	94%	Very Practical
20	T	90	90%	Very Practical
21	U	74	74%	Practical
22	V	66	66%	Practical
23	W	79	79%	Practical
24	X	82	82%	Very Practical

25	Y	78	78%		Practical
26	Z	77	77%		Practical
27	AA	89	89%		Very Practical
28	AB	81	81%		Very Practical
	Total Score			2235	
	Average Percentage			79, 82 %	
	Criteria			Practical	

To strengthen the quantitative data, interviews were conducted with the mathematics teacher and several students to obtain more in-depth information on the use of this Discovery Learning-based E-LKPD. The subject teacher stated that the use of E-LKPD was beneficial in the learning process. He said that "Students are more enthusiastic because the LKPD display is attractive and interactive. They can learn independently first before I explain. Moreover, it is context-based, so students are not just memorizing formulas."

Meanwhile, students selected based on questionnaire scores (high, medium, and low) generally gave positive responses. For example, a student with the initials M who scored 97% said: "I prefer using online LKPD like this, the questions are clearer and you can repeat them yourself if you don't understand." Student F, who scored 68% also considered the E-LKPD useful, despite encountering a few technical obstacles: "It's nice, it's easier to open on my phone. But sometimes my connection is bad, so it lags a bit when opening it." Meanwhile, student R (80%) said: "The questions make you think, but because there are examples and steps, I understand better."

Furthermore, several other students also provided responses that demonstrated active engagement and increased understanding of the material. Student C (80%) said: "I understand better because I can try it myself and the answers can be seen immediately. Usually I get confused when it comes to stories, but now it is easier because there are steps." Student G (84%) added: "I like using this LKPD because it can be opened on my phone and the display is attractive. Usually printed books are boring, but this is like playing a game." Meanwhile, student V (66%), who is in the low-scoring category, also felt helped: "At first I was confused about how to open it, but after it was explained, I was able to follow along. The good thing is that I can try again and again until I understand."

The interview results indicate that the use of E-LKPD generally increases student engagement and aids conceptual understanding, particularly in solving contextual problems. This aligns with research showing that the Discovery Learning model can encourage students to discover concepts and principles for themselves, thus creating meaningful learning (Butar-butar et al., 2020). Support for interactive media, such as LiveWorksheets, also strengthens this, as Aisyah, Psb, and Sofiyah (2025), that interactive digital media can improve students' understanding of mathematical learning concepts. Therefore, based on the triangulation of questionnaire and interview data, it can be concluded that the Discovery Learning-based e-LKPD developed is practical, enjoyable, and effective in supporting algebra learning at the junior high school level.

The evaluation stage is the final step in the media development process, following validation and trial. At this stage, researchers refined the product based on expert input and student responses. Revisions were conducted in a targeted manner to optimize the quality of the developed e-LKPD. Based on expert validation results and practicality analysis from the trial, the Discovery Learning-based e-LKPD for algebraic forms demonstrated high validity and practicality. Therefore, this media is deemed suitable and effective for use as a learning support tool in the classroom.

CONCLUSION

Based on the research results, it can be concluded that the Discovery Learning-based E-LKPD developed using the Liveworksheets platform for algebra material demonstrates excellent validity and practicality. Validation by material experts yielded 82.89% validity, with a very valid category,

while validation by media experts yielded 94.48%, also with a very valid category. The practicality test showed that the E-LKPD received positive responses from students, with results of 88% in small-class trials (convenient category) and 79.82% in large-class trials (practical category). Thus, this E-LKPD is declared valid and practical, and is suitable for use in the learning process. E-LKPD can support the achievement of learning objectives because it is designed to align with curriculum objectives, student needs, and the characteristics of teaching materials. The presence of this E-LKPD is expected to be an innovative solution in providing more interactive, engaging, and meaningful learning for students.

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