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DEVELOPING MICROSOFT EXCEL-ASSISTED DISCOVERY LEARNING TOOL TO IMPROVE STUDENTS' MATHEMATICAL PROBLEM SOLVING AND SELF-CONFIDENCE ON ELEMENTARY SCHOOL

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ABSTRACT

Learning the concepts of Least Common Multiple (LCM) and Greatest Common Factor (GCF) remains challenging for some elementary school students, particularly in understanding concepts and solving related mathematical problems. Preliminary observations and interviews with fifth-grade teachers and students indicated that these difficulties were partly associated with the limited availability of appropriate learning tools and instructional models. Therefore, this study aimed to develop and evaluate learning tools for teaching LCM and GCF, consisting of Microsoft Excel-based learning media, Discovery Learning-based student worksheets, and instructional materials. This study employed a research and development (R&D) method based on the Borg and Gall development model. The research subjects were fifth- and sixth-grade students at a public elementary school in West Bandung Regency. Data were collected using learning-tool validity and practicality validation sheets, a mathematical problem-solving ability test, and a self-confidence scale. The results showed that the developed learning tools achieved high validity and high practicality criteria. Furthermore, there were significant differences in students' mathematical learning outcomes and self-confidence between the experimental and control classes. However, the effectiveness of the developed learning tools in the experimental class was not optimal due to limitations in the availability of facilities and infrastructure supporting the implementation of interactive media and the Discovery Learning model. In conclusion, the developed learning tools were valid and practical for supporting LCM and GCF instruction, although their effectiveness depends on adequate technological facilities and appropriate implementation of the learning model.

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INTRODUCTION

Mathematics education at the elementary school level, particularly in fifth grade, plays a crucial role in laying the foundation for logical, critical, and systematic thinking among students. Mathematics should no longer be viewed merely as a rigid discipline of arithmetic but must be directed as a means to hone mathematical problem-solving ability. This ability is an essential competency that serves as the core of mathematics education, training students in higher-order thinking skills (Hidayat et al., 2021). Through strong problem-solving skills, elementary school students will demonstrate a higher level of adaptability in solving various logical problems, even outside their academic context (Putri & Syarifuddin, 2022). The urgency of mastering this competency also serves as a crucial foundation in numeracy for students as they face the challenges of national assessments that demand deep reasoning (Sari & Sholihah, 2023). Structurally, mathematical problem-solving skills help elementary school students identify information systematically, select appropriate strategies, and re-evaluate the results obtained (Wahyudi et al., 2024). Therefore, failure to cultivate and develop problem-solving skills early on in elementary school is predicted to significantly hinder students' science and technology literacy at subsequent educational levels (Pratama & Lestari, 2025).

However, the reality on the ground today shows conditions that run counter to that ideal. Various recent studies consistently report that elementary school students' mathematical problem-solving skills remain at an alarming level. When faced with Polya's problem-solving procedure, the majority of students make critical errors, particularly in the stages of understanding the essence of the problem and planning the solution steps (Siregar & Fauzi, 2021). This low level of proficiency is underscored by the fact that more than 60% of fifth-grade elementary school students were found to be unable to solve math problems requiring contextual modeling (Lestari et al., 2022). The root causes of this problem stem primarily from classroom practices, where students are often given mechanical and rote-learning exercises without being taught a deep conceptual understanding (Kurniawan & Rahayu, 2023). As a result, the average scores for students' mathematical problem-solving skills in most elementary schools remain far below the established minimum proficiency standard (Utami & Junaedi, 2024). A psychological phenomenon frequently observed in the field is that students tend to give up immediately and are reluctant to try when the wording or phrasing in a math problem is made slightly more complex than the examples provided by the teacher (Ramadhan et al., 2025).

In addition to cognitive aspects, students' academic success in mathematics is also determined by strong affective aspects, one of which is self-confidence. Self-confidence in the context of mathematics refers to students' internal belief in their own potential to face challenges, present arguments, and recover from errors in reasoning. This affective trait acts as a psychological driving force that makes students more active and less afraid of making mistakes during group discussions (Yusuf & Fitriani, 2021). Empirically, there is a highly significant positive correlation between high levels of self-confidence and students' academic performance in mathematics (Ningsih & Purwanto, 2022). When students have strong self-confidence, the level of math anxiety that often plagues them can be reduced to a minimum (Ahmad et al., 2023). This self-confidence also fosters mental resilience (grit), which makes students refuse to give up when solving complex math problems (Saputri & Zulkardi, 2024). Instilling and nurturing self-confidence starting in the fifth grade of elementary school provides students with essential mental preparedness before they transition to the learning environment of secondary school (Dewi & Hartono, 2025).

Unfortunately, the current climate of mathematics education still often portrays the subject as a frightening specter, which has a detrimental effect on students' self-confidence. Students' psychological state in the classroom reveals that most children feel insecure, anxious, and

reluctant to volunteer to come to the front of the class to solve problems due to a deep-seated fear of being laughed at by their peers (Fadilah & Setiawan, 2021). This lack of self-confidence is also clearly evident in the bad habit of students who choose to copy their peers' answers en masse rather than relying on their own independent thinking (Wulandari et al., 2022). This affective barrier is further exacerbated by the emergence of a sense of helplessness (learned helplessness) among students when teachers present new types of questions that differ from the usual ones (Hasanah & Maryani, 2023). This is reinforced by the fact that a lack of appreciation for the learning process in the classroom gradually erodes students' self-confidence (Rizki & Kusuma, 2024). Ironically, recent research data confirms that fewer than 30% of fifth-grade elementary school students have the courage to ask questions or express their opinions voluntarily in mathematics classrooms (Puspita et al., 2025).

To bridge the cognitive gap manifested as low problem-solving skills and the affective gap manifested as low self-confidence a substantive reform of learning is needed through the development of structured learning materials. The innovative and strategic solution proposed in this study is to develop learning materials based on the Discovery Learning model, supported by Microsoft Excel. This approach is based on the idea that carefully and systematically designed learning materials can guide students to construct their own knowledge independently (Amalia & Dahlan, 2021). Furthermore, the integration of cutting-edge technology into instructional materials has been shown to accelerate the visualization of abstract mathematical concepts, making them more concrete for elementary school-aged children (Pratiwi et al., 2022). The Discovery Learning model was chosen because its syntactic characteristics are highly effective in stimulating students' curiosity through guided stages of stimulation and problem identification (Nugroho & Handayani, 2023). When this model is integrated with Microsoft Excel, students will have an interactive and enjoyable learning experience because they can manipulate numerical data and observe changes in patterns directly on the computer screen (Sanjaya et al., 2024). This combination of an activity-based discovery model and computer-based media is believed to accommodate the diverse learning styles of elementary school students, thereby ensuring a more lasting understanding of the material (Fitriah & Wardani, 2025).

Specifically, on the one hand, the integration of Discovery Learning syntax with the optimization of interactive spreadsheet features and Visual Basic for Applications (VBA) in Microsoft Excel has been empirically proven to simultaneously boost students' learning outcomes. The investigative steps in Discovery Learning have been shown to sharpen students' thinking skills, which in turn linearly improves their problem-solving scores (Marpaung & Sinaga, 2021). On the other hand, the automatic graphical visualizations provided by Microsoft Excel greatly help elementary school-aged children grasp the essence of patterns and fractions using their own five senses (Kusumawardani et al., 2022). The use of this Excel-based interactive media also sparks students' enthusiasm to experiment, which directly leads to an increase in their self-confidence scores (Simanjuntak & Ginting, 2022). Through Discovery Learning-based worksheets, the learning paradigm can be completely transformed from a teacher centered approach to one centered on student engagement (Permana & Wijaya, 2023). The advantage of Excel or VBA Excel based math simulations lies in their ability to provide instant feedback, so that students do not feel pressured or afraid of making mistakes, which ultimately boosts their self-confidence (Anwar & Lestari, 2024). This integration has been shown to have a high effect size on children's analytical acuity and numerical problem-solving skills (Budiman & Rahmawati, 2024). Ultimately, the combination of the discovery based model and the practicality of Microsoft Excel has proven effective in creating a supportive classroom ecosystem, boosting motivation, and simultaneously sharpening students' mathematical problem-solving skills (Sholehah et al., 2025).

Although numerous studies have been conducted on the Discovery Learning model and the use of digital media, an in-depth review of previous literature indicates that most research still focuses on the secondary school level (junior high and high school) and uses complex software such as GeoGebra or SPSS, which are not particularly user-friendly for elementary school-aged children. Furthermore, Microsoft Excel has generally been viewed by teachers merely as an administrative tool for office work or a tool for processing grades, and is rarely optimized as an interactive discovery medium that elementary school students can operate directly themselves. This is where the state-of-the-art nature and novelty of this study lie. The novelty of this study lies in the comprehensive integration of instructional materials (syllabus, lesson plans, student worksheets, and assessment instruments) that combine the Discovery Learning approach with the use of interactive Microsoft Excel worksheets designed with a child-friendly approach specifically for fifth-grade elementary school students. Furthermore, this study utilizes Microsoft Excel's spreadsheet features and simple macro formulas as a mini-laboratory where students can independently experiment to discover geometric formulas, number patterns, or basic statistics. The focus of this study also offers a comprehensive balance between measuring improvements in higher-order cognitive skills (mathematical problem-solving) and strengthening affective aspects (self-confidence) within a single learning intervention.

Based on the issues and gaps outlined above, this study generally aims to address these challenges through several main objectives. First, this study aims to develop a Discovery Learning-based instructional tool supported by Microsoft Excel for fifth-grade elementary school students that meets standard criteria for validity, practicality, and effectiveness. Second, this study aims to empirically test the effectiveness of the developed instructional materials in improving the mathematical problem-solving skills of fifth-grade elementary school students. Third, this study also aims to test the effectiveness of the developed instructional materials in boosting the self-confidence of fifth-grade elementary school students in participating in mathematics lessons.

METHOD

The method used to address the research question in this study is the Research and Development (R&D) method. According to Sugiyono (2012), the research and development method is a research method used to produce a specific product and test the effectiveness of that product. Thus, research and development is a process used to develop and validate products used in the educational process (Slamet, 2022). This is in line with the opinion of Waruwu (2024), who states that research and development is a scientific activity carried out in a planned and systematic manner based on problem analysis with the aim of developing a new innovation whether in the form of a product or a model that is useful to society and whose feasibility and effectiveness can be scientifically tested. This research method was chosen because it aligns with the study's characteristics, namely the development of a product that begins with an analysis of a problem, where the innovative product is validated by experts and tested on research subjects. Thus, the primary objective of this Research and Development method is to produce a product developed through a scientific process that can be beneficial to society.

The design used is the Gall, Gall & Borg (2003) development model. This development model was chosen because the resulting product aligns with the problem analysis or identified needs. The product testing phase was conducted more than once, ensuring that the product could yield significant improvements. The following is a diagram of the Borg and Gall development model, which outlines a systematic approach to product development.

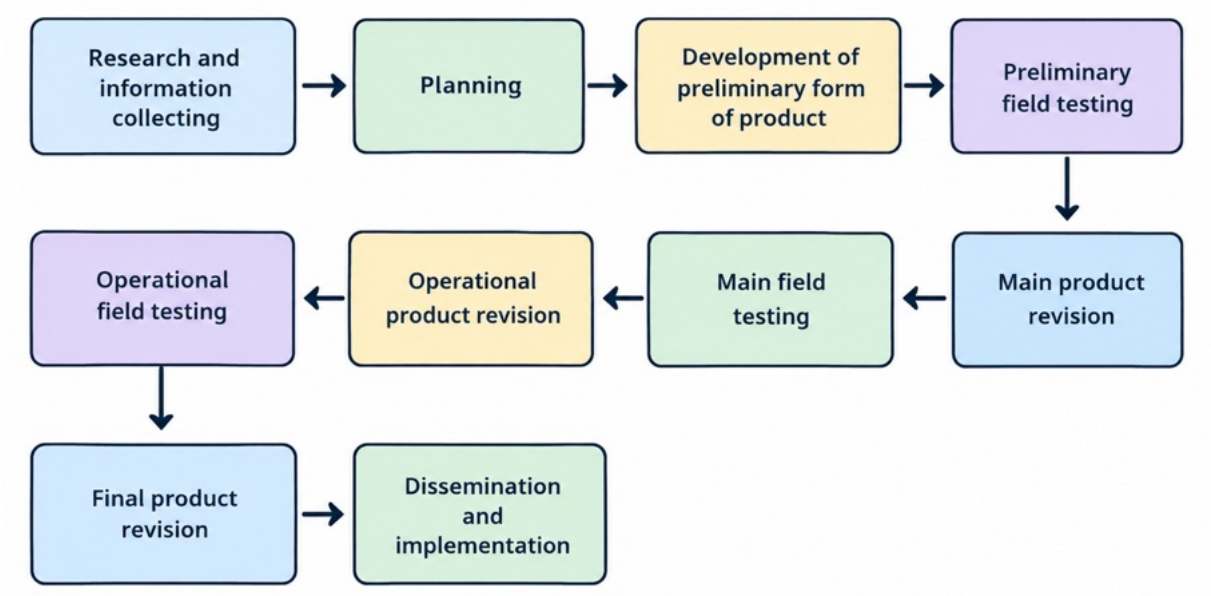

Figure 1. Borg and Gall Development Flowchart

Based on the diagram above, the stages of development according to Borg and Gall can be explained as follows:

1. Research and Information Collecting, In this initial stage, the researcher gathers information regarding the problem to be researched through interviews and a review of relevant literature.
2. Planning, In this stage, the researcher conducts planning, formulates competencies, and determines the objectives to be achieved.
3. Development Product, This stage is the development of the initial form of the product, namely learning tools consisting of Microsoft Excel-assisted media, Discovery Learning-based Student Worksheets (LKPD), and teaching materials on the LCM and GCF of two numbers using the table method.
4. Preliminary Field Testing, In this stage, the researcher conducts a limited field trial.
5. Main Product Revision, In this stage, the researcher makes product improvements based on the results of the limited trial.
6. Main Field Testing, In this stage, the researcher conducts a large-scale main field trial.
7. Operational Product Revision, In this stage, the researcher makes product improvements based on the results of the large-scale field trial.
8. Operational Field Testing, At this stage, researchers conduct product trials, where they test the effectiveness of the resulting product. The product trials are conducted in two classes: an experimental class where learning is implemented using the developed learning tools and a control class with standard learning.
9. Final Product Revision, At this stage, researchers make final improvements to the resulting product.
10. Dissemination and Implementation, At this stage, researchers disseminate the developed product.

This study was conducted at a public elementary school in West Bandung Regency. Since this school does not yet have a computer lab, four laptops were used as interactive learning tools for this study. The classrooms, where students typically learn, averaged 8 meters in length and 7 meters in width. Each class had more than 40 students. A pilot study was conducted with 10 sixth-grade students. Subsequently, during the main field trial phase, the researcher conducted a large-scale field trial with 44 students in Class VA. Subsequently, the researcher conducted a

product trial to test the effectiveness of the developed learning tool. The product trial was carried out with Class VC, consisting of 42 students, as the experimental class, where instruction was delivered using the developed learning tool, while Class VB, consisting of 43 students, served as the control class, receiving conventional instruction.

The instruments used in this study included an interview guide, a content expert validation questionnaire, a media expert validation questionnaire, teacher and student response questionnaires, a problem-solving skills test, and a self-directed learning questionnaire. The interview guide was used during the needs analysis phase to gather information about the state of mathematics learning, student characteristics, and teachers' needs regarding instructional materials. The subject matter expert validation questionnaire was used to assess the appropriateness of the content, the accuracy of concepts, the presentation, and the alignment of the learning materials with the principles of Discovery Learning. Meanwhile, the media expert validation questionnaire was used to assess the design, appearance, readability, navigation, ease of use, and visual quality of the learning materials developed using Microsoft Excel. The student response questionnaire was used to determine the practicality of the product after it was implemented in the classroom. To measure the product's effectiveness, a problem-solving test in the form of essay questions was administered before and after instruction (pretest and posttest), while the learning confidence questionnaire was used to determine changes in students' level of independent learning after using the worksheets.

The results of the validators' assessments were analyzed, and percentages were calculated to measure the suitability of the instructional materials. The practicality test for the learning tools was conducted by filling out a practicality test validation sheet. The content of the learning tool validation sheet, created using Microsoft Excel, covers four aspects: usefulness, appeal, novelty, and supportiveness. The assessment criteria were evaluated using a Likert scale. The results of the validators' assessments were analyzed, and a percentage was calculated to measure the practicality of the learning tools. An effectiveness test was conducted to determine the extent to which the developed instructional materials influenced the expected outcomes. The pretest and posttest results were analyzed using Microsoft Excel and SPSS software, applying the two-sample independent t-test formula or the nonparametric Mann-Whitney test.

In addition to problem-solving skills, the developed product is expected to enhance students' self-confidence. To test this, the researcher used a self-confidence attitude scale administered to students during the pilot study and product testing. Self-confidence consists of four indicators: belief in one's own abilities, courage to express opinions, independence, and optimism. The attitude scale consists of 24 statements, comprising 12 positive and 12 negative statements. Responses were rated using a Likert scale. The results of the attitude scale were analyzed, and percentages were calculated to measure students' self-confidence levels.

RESULTS AND DISCUSSION

Results

Instructional Materials Development

In this study, the instructional materials developed were: Microsoft Excel-based instructional media, discovery learning-based worksheets, and teaching materials. The steps for developing the instructional materials using the Borg and Gall model are as follows:

During the research and information-gathering phase, the study involved classroom observations, interviews with fifth-grade teachers, the distribution of questionnaires to students, and an analysis of the curriculum and instructional materials that had been used. The results of the analysis showed that mathematics instruction in the classroom was still dominated by lectures and problem-solving exercises, while digital learning media had not yet been utilized

optimally. Students tended to have difficulty understanding contextual problems, determining solution strategies, and checking their answers. In addition, most students also exhibited relatively low levels of self-confidence when asked to express their opinions, participate in discussions, or present their work in front of the class. These findings served as the basis for designing instructional materials capable of facilitating active learning through the Discovery Learning model, integrated with Microsoft Excel as an interactive medium.

Based on the results of this needs analysis, the planning phase focused on developing instructional materials, including teaching modules, Student Worksheets (LKPD), Microsoft Excel-based learning media, a mathematical problem-solving skills test, a self-confidence questionnaire, and other assessment tools. All materials were designed to align with the learning outcomes of the Merdeka Curriculum and the Discovery Learning syntax, namely stimulation, problem statement, data collection, data processing, verification, and generalization. Microsoft Excel was utilized as an interactive medium that allows students to explore concepts through tables, graphs, automatic formulas, simple simulations, and immediate feedback on their work, thereby making learning more engaging and providing a meaningful learning experience.

The next stage is the development of a preliminary form of the product, which involves creating a prototype of the instructional material that is then validated by subject matter experts, media experts, and language experts. The validation results showed that the instructional material met the criteria for content appropriateness, content feasibility, language quality, media presentation, ease of use, and suitability for the characteristics of elementary school students. The validators also provided several suggestions for improvement, such as refining the Microsoft Excel interface, simplifying the language in the worksheets, adding contextual illustrations, and refining the problem-solving skill indicators. This feedback was then used as the basis for revising the product so that its quality would be further improved before it was pilot-tested with students.

After undergoing a revision process, the instructional materials were pilot-tested with a small group during the preliminary field testing phase. The results of the pilot test showed that students were able to use Microsoft Excel with ease and follow each stage of Discovery Learning independently. Students also responded positively to the developed materials, as they were considered helpful for the learning process, made it easier to present the material, and increased student engagement during the learning process. However, the initial test results also revealed several areas that still need improvement, particularly regarding the instructions for using the software, font size, layout, and menu navigation, to make them easier for elementary school students to understand.

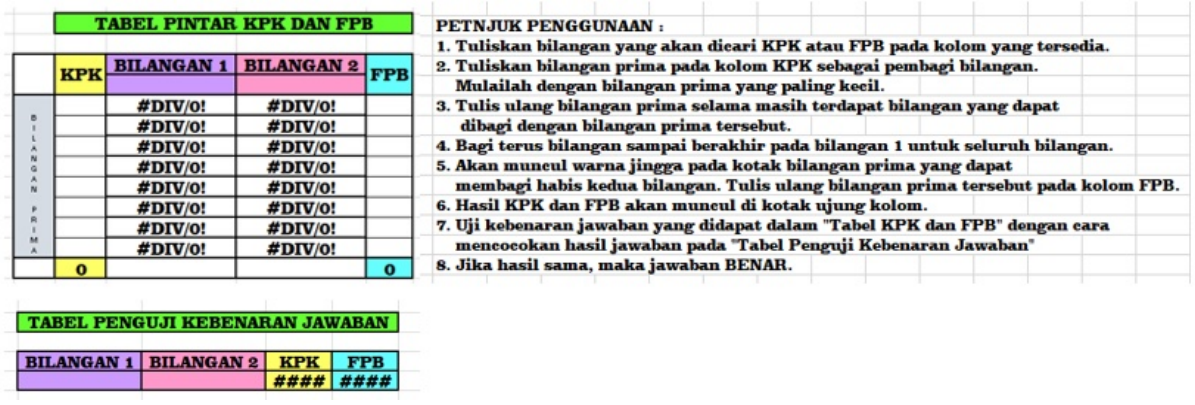

Figure 2. Microsoft Excel Learning Media

Figure 3. Discovery Learning Worksheets

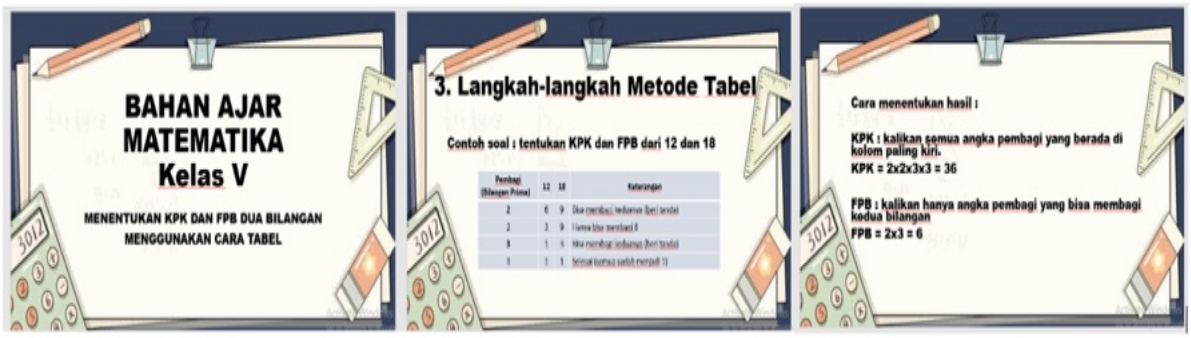

Figure 4. Teaching Materials

The improvements made during the main product revision phase resulted in a learning tool that is simpler, more engaging, and easier to use. Refinements were made to the visual design, contextual example problems were added, automated feedback in Microsoft Excel was improved, and learning activities were adjusted to better suit students' abilities. The revised product was then retested on a larger group through the main field testing phase. The implementation results showed that all aspects of Discovery Learning were carried out very well. Students appeared more active in identifying problems, gathering information, processing data, testing their findings, and drawing conclusions independently. Learning activities that were originally teacher-dominated shifted to student-centered learning, resulting in more intensive interactions among students as well as between teachers and students. The improvements can be seen in Figures 5:

Figure 5. Teaching Materials Before (Left) and After (Right) Revision

The practicality of the instructional materials was also evident from the results of the student feedback survey, which rated them as "very practical." Students stated that the materials used were engaging, easy to understand, provided an enjoyable learning experience, and helped them understand the steps for solving math problems in a more systematic way. This ease of use indicates that the revisions made based on the results of previous pilot tests successfully improved the quality of the instructional materials significantly.

The operational field testing phase was conducted to evaluate the effectiveness of the instructional materials on a larger scale. The research results indicate an improvement in students' mathematical problem-solving skills after participating in lessons using the developed materials. This improvement was evident in students' ability to understand problems, design solution strategies, carry out solution procedures, and review their answers. In addition, students' self-confidence also increased, as demonstrated by their willingness to express their opinions, increased participation in group discussions, willingness to present their work in front of the class, and confidence in solving math problems independently. These improvements indicate that the implementation of Discovery Learning supported by Microsoft Excel is capable of creating a learning environment that provides students with the opportunity to discover concepts independently, gain more meaningful learning experiences, and build confidence in their own abilities.

Next, during the final product revision stage, all feedback gathered during the operational trial was used to refine the final product. Revisions were made to several components of the learning materials to make them easier for both teachers and students to use, in terms of content, appearance, and instructions for use. After all development stages were completed, the learning tool was then disseminated through the dissemination and implementation phase as a final product ready for use in elementary school mathematics instruction. The resulting product was deemed capable of supporting the implementation of the Merdeka Curriculum because it integrates discovery-based learning with the use of simple technology that is easily accessible to teachers.

Suitability of Instructional Materials

Media validation was conducted to assess the suitability of the VBA Excel-based Discovery Learning instructional materials used in the learning process. This validation aimed to determine the suitability of the media in terms of presentation and the suitability of the content in terms of learning material. The validation was conducted by subject matter experts and media experts using a pre-designed instrument. The results of the validation test for the VBA Excel-based instructional media are presented in Table 1:

Table 1. Results of the Validity Test of Microsoft Excel-Assisted Learning Media

Validation Aspects	Average Score	Maximum Score	Percentage	Criteria
Completeness	4,3	**5**	86	Very Valid
Presentation	4,5	**5**	90	Very Valid
Suitability	4,67	**5**	93,40	Very Valid
Ease of Accessibility	5	**5**	100	Very Valid
Average percentage			92,35	Very Valid

Based on Table 1, the results of the validity test for the VBA Excel-assisted learning media showed an average percentage of 92.35%, which falls into the "highly valid" category. The indicator with the highest score was in the aspect of ease of accessibility at 100%, while the lowest score was in the aspect of completeness at 86%. Thus, the learning media is considered highly valid and can be used without revision. Furthermore, the results of the validation of the Discovery Learning-Based Worksheets are presented in Table 2:

Table 2. Results of the Validity Test for Discovery Learning-Based Instructional Materials

Validation Aspects	Average Score	Maximum Score	Percentage	Criteria
Concept Discovery Elements	4,6	**5**	92	Very Valid
Appearance	4,15	**5**	83	Very Valid
Language	4,6	**5**	92	Very Valid
Completeness	4,35	**5**	87	Very Valid
Model Compliance	4,5	**5**	90	Very Valid
Average percentage			88,80	Very Valid

Based on Table 2, the results of the validity test for the discovery learning-based instructional media showed an average percentage of 88.80%, falling into the "highly valid" category. The indicator with the highest score was in the aspect of conceptual and linguistic discovery, at 92%, while the lowest score was in the aspect of completeness, at 87%. Thus, the learning media is considered highly valid and suitable for use in supporting the improvement of mathematical problem-solving skills. Next, a validity test of the teaching materials was conducted, the results of which are presented in Table 3:

Table 3. Results of the Validity Test of Teaching Materials

Validation Aspects	Average Score	Maximum Score	Percentage	Criteria
Content	4,8	**5**	96	Very Valid
Language	5	**5**	100	Very Valid
Presentation	4	**5**	80	Very Valid
Average percentage			92	Very Valid

Based on Table 3, the validity test of the instructional materials showed that the highest score was in the "Relevance" aspect at 100%, while the lowest score was in the "Presentation" aspect at 80%. Thus, the instructional materials developed are considered highly valid and suitable for use in supporting the improvement of mathematical problem-solving skills.

The Practicality of Learning Tools

To test the practicality of the learning materials, the students filled out a practicality validation sheet covering four aspects. Here are the results:

Table 4. Results of the Practicality Test of Learning Devices

Research Stage	Aspect				Average	Percentage	Category
	Usefulness	Attraction	Updates	Assistance			
Limited trials	3,66	3,58	3,7	3,72	3,66	91,5%	Very practical
Extensive trials	3,33	3,28	3,28	3,29	3,29	82,25%	Very practical
Product trials	3,32	3,31	3,28	3,28	3,3	82,5%	Very practical
Average	**3,44**	**3,39**	**3,42**	**3,43**	**3,42**	**85,5%**	Very practical

Based on Table 4, the summary of student responses from the limited-scale pilot test through the full-scale pilot test shows stable and consistent scores, with an overall average of 85.5%. This result falls within the "Very Practical" criterion, indicating that the worksheets,

instructional materials, and learning media developed are very easy for students to understand and engaging.

Effectiveness in Mathematical Problem-Solving Skills

The test was conducted to evaluate the effectiveness of the instructional materials on students' mathematical problem-solving skills. The test was administered to two classes: the experimental class and the control class. The experimental class received instruction using the developed materials, while the control class received standard or conventional instruction. The results regarding effectiveness are presented in Table 5:

Table 5. Summary of Students' Mathematical Problem Solving Ability Test Results

Statistics	Experimental Class			Control Class		
	Pretest	Postest	N-Gain	Pretest	Postest	N-Gain
Mean	10,16	67,29	0,64	18,39	70,14	0,63
Standard Deviation	4,561	8,219	0,08	9,818	6,813	0,11
Number of Students		31			28	

Based on Table 5, for the experimental class on the pretest, the mean, standard deviation, N-Gain, and number of students were 10.16, 4.561, and 31, respectively; and for the control class, the mean, standard deviation, and number of students were 18.39, 9.818, and 28. From this data, there is a difference in the mean score of 8.23; since this difference is quite large, it can be inferred that there is a difference in students' mathematical problem-solving abilities between those who learned using VBA Excel-assisted discovery learning-based learning tools and those who received conventional instruction. Meanwhile, for the experimental class on the posttest, the mean score, standard deviation, and number of students were 67.29; 8.219; 31, and for the control class on the posttest, the mean, standard deviation, and number of students were 70.14; 6.813; 28. From the data, there is an average difference of 2.95; this difference is relatively small, so it can be inferred that there is no difference in students' mathematical problem-solving abilities between those who were taught using VBA Excel-assisted discovery learning-based instructional materials and those who were not. In terms of N-gain, the experimental class achieved an N-gain of 0.64, while the control class achieved an N-gain of 0.63. This difference is quite small, so it can be inferred that there is no difference in the improvement of students' mathematical problem-solving skills between those taught using a discovery learning-based instructional tool supported by VBA Excel and those taught through conventional instruction.

Effectiveness in Building Students' Self-Confidence

In addition to mathematical problem-solving skills, the learning tools developed were also evaluated from an affective perspective, specifically self-confidence. The results regarding the effectiveness of self-confidence are presented in Table 6:

Table 6. Summary of Attitude Scale Test Results

Statistics	Experimental Class	Control Class
Average	2,95	2,91
Percentage	73,75 %	72,75 %
Number of students	31	28

Based on Table 6, the values obtained for the experimental class were a mean of 70.76, a standard deviation of 12.021, and a class size of 31; while for the control class, the values were a mean of 69.88, a standard deviation of 12.791, and a class size of 28. From these data, the

difference in means is 0.88; this difference is relatively small, suggesting that there is no difference in students' self-confidence between those whose learning utilized VBA Excel-assisted discovery learning-based instructional tools and those in the conventional learning group.

To test the above assumption, an inferential statistical test is required to test the hypothesis. Before conducting the hypothesis test, a normality test was first performed to determine whether the data are normally distributed or not. Since the sample size is less than 50, the Shapiro-Wilk test was used for the normality test. The results are shown in Table 7:

Table 7. Normality Test Result

Variables	Class	Shapiro-Wilk		
		Statistics	df	Sig.
Pretest	Experimental	0,834	31	0,000
	Control	0,927	28	0,051
Postest	Experimental	0,437	31	0,000
	Control	0,935	28	0,083
N-Gain	Experimental	0,457	31	0,000
	Control	0,768	28	0,000
Self Confidence	Experimental	0,740	38	0,000
	Control	0,778	41	0,000

Based on the data above, it can be seen that most of the Sig. values are less than 0.05, indicating that the data are not normally distributed. Therefore, the hypothesis test was subsequently conducted using the Mann-Whitney U test to assess the significance of the difference in the average rankings between the experimental and control classes. A summary of the hypothesis test results is presented in Table 8:

Table 8. Mann-Whitney Test Results

Variables	Class	Mean Rank	Asymp.Sig.(2-tailed)
Pretest	Experimental	22,89	0,001
	Control	37,88	
Postest	Experimental	25,08	0,017
	Control	35,45	
N-Gain	Experimental	30,74	0,726
	Control	29,18	
Self Confidence	Experimental	41,05	0,694
	Control	39,02	

Based on Table 8, the pretest to assess problem-solving ability yielded a value of 0.001; since the significance value is less than 0.05, it is concluded that there is a difference in the initial mathematical problem-solving ability between students who were taught using VBA Excel-assisted discovery learning materials and those who were taught using conventional methods, since a difference was already evident in the pretest results, hypothesis testing was not necessary. For the N-Gain test, a significance value of 0.726 was obtained; therefore, it can be concluded that there is no difference in the mathematical problem-solving abilities of students whose learning utilized a discovery learning-based instructional tool supported by VBA Excel compared to those who received conventional instruction. This indicates that the implementation of a discovery learning-based instructional tool supported by VBA Excel is not effective in improving problem-solving abilities. For self-confidence, a significance value of

0.694 was obtained; therefore, it is concluded that there is no difference in students' self-confidence between those taught using a discovery learning-based learning tool supported by VBA Excel and those taught using conventional instruction. This indicates that the implementation of a discovery learning-based learning tool is not effective in improving students' self-confidence.

Discussions

Development of Instructional Materials

Based on the research findings described above, it can be concluded that the process of developing instructional materials is consistent with the steps outlined by Borg and Gall. These Borg and Gall development steps result in valid and practical instructional materials. This is supported by the opinion of Alimuddin et al., (2024), who state that their research fully implemented the 10 steps of Borg and Gall, from the preliminary study through dissemination. The resulting product achieved very high validity, indicating that the Borg & Gall model is suitable for use in developing Discovery-based learning materials. Furthermore, Ulum, Mu'arifin, & Heynoek (2021) stated that their research developed Discovery Learning materials using the Borg & Gall model and demonstrated that the development stages produced materials suitable for use in instruction. Similarly, Putri & Mulyono (2025) found that their research utilized the Borg & Gall Research and Development model, encompassing needs analysis, product design, expert validation, revision, limited pilot testing, and the final product. The research results indicate that the Borg & Gall stages are capable of producing valid Discovery Learning materials suitable for use.

Suitability of Instructional Materials

Based on the research findings, it was concluded that the VBA Excel-assisted discovery learning-based instructional materials fall into the "highly valid" category. This aligns with the study by Sugandi et al., (2025), which stated that the validity of Canva-based Problem-Based Learning (PBL) e-worksheets falls into the "highly valid" category. Furthermore, Sugandi et al., (2025) stated that the validity of E-LKPD based on discovery learning and supported by Google Sites falls into the "valid" category. The VBA Microsoft Excel-based discovery learning instructional materials achieved the "highly valid" category because they were developed systematically in accordance with R&D standards and met the five validity criteria (content, construct, language, presentation, and media).

The construct and content validity stem from the alignment of learning activities with Bruner's syntax (from stimulation to generalization) and the graded progression of the material in accordance with learning outcomes (Anggraini et al., 2022; Kari et al., 2022; Wahyudiniar & Sopiany, 2024). In terms of media and instructional materials, the integration of interactive VBA Excel features (simulations, visualizations, and automatic feedback) along with constructivist worksheets successfully facilitated independent and intuitive exploration of concepts (Syarikasari et al., 2025; Bimayu et al., 2025). Combined with communicative language, balanced visual design, and an iterative revision process based on input from experts and practitioners, this tool has proven to be technically and pedagogically sound (Budiman, 2021; Dewi et al., 2025). The integration of all these elements aligns with the findings of the meta-analysis by Febrinanda & Ardi (2024), which confirms that Discovery Learning-based tools consistently demonstrate high validity and are ready for implementation in mathematics education.

Based on the research findings, it was concluded that the discovery learning-based instructional tool supported by VBA Excel falls into the "highly practical" category. This aligns with the study by Sugandi et al. (2024), which states that the feasibility of PBL-based E-LKPD

supported by a web-based live worksheet for enhancing mathematical critical thinking skills falls into the "practical" category. The high level of practicality of the Discovery Learning-based instructional tool supported by Microsoft Excel VBA is the result of a synergy between the tool's usefulness in simplifying the learning process, its visually appealing design that enhances learning motivation, the support provided by interactive features that facilitate conceptual discovery, and the innovative integration of Excel VBA technology with the Discovery Learning framework. These four aspects make the tool easy to implement, easy to understand, and very well received by both teachers and students. These findings are consistent with the research by Dewi, Sugandi, and Rosyana (2025) as well as Syarikasari et al. (2025), who concluded that Discovery Learning-based instructional tools integrated with Microsoft Excel are categorized as highly practical because they increase student engagement, make it easier for teachers to manage the learning process, and create a more interactive learning experience compared to conventional learning.

Effectiveness in Mathematical Problem-Solving Skills

Based on the research findings, it was concluded that the implementation of VBA Excel-assisted discovery learning tools is ineffective in improving problem-solving skills. The ineffectiveness of VBA Excel-assisted discovery learning tools stems from students' internal limitations and practical implementation challenges. From the students' perspective, low levels of prerequisite knowledge and varying levels of digital literacy lead to increased cognitive load, shifting their focus from developing problem-solving strategies to basic understanding and operating the technology (Mugni et al., 2021; Aeni et al., 2024). Finally, the short duration of the intervention and the nature of Discovery Learning which focuses on conceptual discovery rather than explicitly on problem-solving result in suboptimal improvements in higher-order thinking skills (Anwar, 2024).

Effectiveness in Building Students' Self-Confidence

Based on the research findings, it was concluded that the use of VBA Excel-assisted discovery learning tools is ineffective in increasing students' self-confidence. The ineffectiveness of VBA Excel-assisted discovery learning tools in boosting self-confidence stems from students' internal factors and implementation challenges. Building self-confidence requires a long time, affective reinforcement, and consistent guidance; therefore, brief, cognitively oriented interventions have not yet had a significant impact (Geong & Mahmudi, 2023; Wulansari & Nugraha, 2025). On the other hand, limited digital literacy and the dominance of high-ability students create cognitive load and academic anxiety for passive students (Badriyah et al., 2023).

In line with previous studies, the use of interactive learning media has generally been shown to be effective in improving students' understanding of learning material. However, it is possible that interactive media may not be significantly more effective at improving student learning outcomes compared to conventional teaching methods. There are several limitations to interactive media, including: a lack of facilities in certain areas, educators' limited ability to use interactive media, students' lack of skills in using interactive media, and students' diverse learning styles (Nugraha et al., 2020). This aligns with the opinion of Putri, Karina Trisna et al. (2025), who state that interactive learning media can help students understand abstract mathematical concepts in a more concrete way; however, its implementation in elementary schools faces various obstacles, including: limited technological infrastructure, low teacher competence in utilizing digital media, and disparities in internet access. Muhammad, Hardian et al. (2025) share the same view that the use of interactive learning media has a positive impact on promoting students' mathematics learning outcomes; however, the effectiveness of the media is highly dependent on other factors such as: teacher readiness, the suitability of the media to the subject matter and student characteristics, and the availability of facilities.

CONCLUSION

Based on the research findings, data analysis, and discussion, it can be concluded that the development of Discovery Learning-based instructional materials supported by VBA Excel was carried out in accordance with the stages of the Borg and Gall research and development model. The resulting instructional materials demonstrated high validity and practicality, indicating that they are feasible for use in elementary mathematics instruction. However, the implementation of the developed instructional materials did not demonstrate effectiveness in improving students' mathematical problem-solving skills or self-confidence. These findings suggest that although the instructional materials were appropriately developed and considered feasible from the perspectives of validity and practicality, their effectiveness may depend on contextual factors, particularly the availability of technological facilities, students' and teachers' familiarity with interactive learning media, and the quality of implementation of the Discovery Learning model.

Based on these findings, several recommendations can be proposed. First, teachers are encouraged to ensure that adequate technological facilities, including computers and supporting equipment, are available before implementing VBA Excel-based learning media. Second, teachers should receive sufficient preparation or training in the use of VBA Excel media and the stages of the Discovery Learning model to ensure that the instructional process is implemented effectively. Third, the developed instructional materials should be further refined through additional trials involving larger and more diverse groups of students and schools. Fourth, future researchers are encouraged to explore modifications to the learning media and instructional strategies, including combining VBA Excel with other interactive or digital learning platforms, to improve students' mathematical problem-solving skills and self-confidence. Finally, further studies should examine the factors that may influence the effectiveness of technology-assisted Discovery Learning, such as students' prior mathematical knowledge, digital literacy, learning motivation, classroom conditions, and teacher competence.

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