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Development of Discovery Learning Tools to Facilitate Junior High School Students' Mathematical Understanding Ability

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ABSTRACT

This research and development (R&D) aim to produce learning tools in the form of syllabus, lesson plans (RPP), and student worksheets (LKPD) based on discovery learning models on geometry flat-side materials to facilitate the mathematical understanding ability of 8th-grade students of junior high school that has met the valid and practical requirements. The development model used is 4-D, consisting of four stages: Define, Design, Development, and Disseminate. The research instruments used in this research are validity instruments in the form of validation sheets and practicality instruments in the form of student response questionnaires. The syllabus, RPP, and LKPD that has been developed are validated by three validators and then tested out. According to data analysis of validation results, learning tools have met the valid requirements with an average score syllabus of 3.93, RPP of 3.86, and LKPD of 3.80. The student response questionnaire showed that the practicality of LKPD has met the practical requirements with an average score of in small group trials 3.61 and large group trials 3.53. Thus, the learning tools developed have met the valid and practical requirements to be used by 8th-grade students of junior high school.

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INTRODUCTION

Mathematics is a field of science that has an important role in the development of science and technology, both as a tool in the applications of other fields of science and in the development of mathematics itself [1]. Mathematics learning needs to be given to all students from elementary, secondary, to higher education, to equip students with the ability to think logically, analytically, systematically, critically, innovatively, and creatively, and work together. Characteristics of learning mathematics in abstract objects of study, truth based on logic, multilevel/continuous material, and interrelationships between materials make some students find mathematics difficult and unpleasant. According to Soedjadi [2], this abstract nature is one of the reasons students experience difficulties in understanding and applying mathematical concepts.

Mathematics material taught at every level of education is integrated. Every mathematical concept is interrelated and related to one another. Therefore, learning mathematics must be carried out systematically so that a good understanding of mathematical concepts is needed so that students can relate mathematical concepts and apply them appropriately. This is the same with one of the objectives in K13, namely understanding mathematical concepts. Concept understanding is an ability to apply concepts in solving problems, connecting various concepts, and developing concepts that have been learned to build new knowledge [3].

Understanding mathematics capacity is an important goal in mathematics learning because the capacity to understand mathematics means that the students are not just repeated but make students better understand the concepts of the material being studied [4]. Understanding concepts would affect mathematical capabilities, such as problem-solving, connections, and math communication [5].

The importance of mathematical understanding abilities is inversely proportional to the reality on the ground, where research by [6] shows that students' mathematical understanding abilities are approximately low. The low ability to understand mathematics causes students to experience difficulties solving math problems [7]. Junior high school students' mathematical understanding skills were still low due to a lack of emphasis on concepts for students and students not used to working on non-routine questions [8]. Students could not relate to each concept and could not appeal to previously learned concepts, so students had difficulty solving problems [9]. Students still had difficulty understanding the material for flat-sided spaces [10]. Research by [11] also shows that students still experience difficulties in solving flat-sided space problems.

One of the things that the teacher must do before carrying out learning activities is to prepare a lesson plan. A lesson plan is needed so teachers focus more on implementing learning [12]. This lesson plan is outlined in a learning tool. In the learning process, a teacher's creativity is needed in using and developing learning tools to carry out learning from learning teacher-centered learning becomes student-centered. Learning tools can increase student enthusiasm to participate actively in the learning process and give students the freedom to develop their creativity based on their abilities, talents, and interests [13].

According to Bruner [3], the best way for students to build their understanding is to construct it themselves through a series of exploration and discovery activities. This aligns with the spirit of the 2013 Curriculum, which requires learning activities that facilitate students to learn actively with student-centered activities. Referring to this view, discovery-based learning is one of the learning models that can be used in learning tools. It is recommended, according to Permendikbud Number 22 of 2016, and facilitates students in building their mathematical understanding. According to [14], this model gains students' active learning by discovering and investigating a concept. It is obtained long-lasting in memory.

Discovery learning consists of six steps, visual stimulation, stating a problem, data collection, data processing, information verification, and generalization. The discovery learning model can improve students' understanding of mathematical concepts [15]. The model discovery learning will provide opportunities for each student to take an active role in learning and can help form effective teamwork to increase students' understanding of mathematical concepts that will be discovered independently [16]. The model discovery learning with a scientific approach provides opportunities for students to think, find, argue, and cooperate through scientific learning activities to train and improve mathematical understanding skills, impacting student learning outcomes [17]. Students are directed to find concepts with their thinking capacity to improve their mathematical understanding abilities [3].

Based on the description above, this study developed a mathematics learning tool (syllabus, RPP, LKPD) based on a discovery learning model on geometry flat-side theme to facilitate the mathematical understanding abilities of 8^{th} junior high school, which included valid and practical requirements. Through the learning tools, students are expected to participate actively in learning activities, construct their knowledge, and discover concepts so that it can facilitate students' mathematical understanding abilities.

METHODS

This research and development (R&D) used the 4-D model by Thiagarajan, which consists of four stages: define, design, development, and disseminate. 'Define' steps carried out activities of several analyses (initial-end, student, concept, task) and formulated the learning objectives. Analysis was found to identify problems, examine student characteristics, develop material concepts for geometry flat-side, and formulate competency achievement indicators (IPK) and learning objectives. Stage design is the stage for compiling the design of a product, including preparation, standard tests, format selection, and basic design.

At the level of development, the learning tools are validated by the validator and one-to-one evaluation is carried out. Small (6 students) and large group trials (25 students) with heterogeneous academic abilities have met the valid LKPD requirements. At this stage, disseminate done packaging in book form and publication of articles in a national journal.

The data obtained are quantitative and qualitative. Quantitative data is inferred as an assessment score on the syllabus, RPP, and LKPD validation sheets. Student response questionnaires to the developed LKPD were used to obtain quantitive data of practicality. Qualitative data were obtained from teacher interviews, validator comments and suggestions on the learning tools validation sheet, and student responses to the response questionnaire on LKPD.

The validity instruments in this study were in the form of syllabus validation sheets, RPP validation sheets, and LKPD validation sheets, which were assessed by the validator. The student response questionnaire is the instrument to carry out the use of LKPD. The types of answers on the validation sheet and student response questionnaires used a Likert scale with the answer choices namely: 1 (Very inappropriate), 2 (Not appropriate), 3 (Appropriate), and 4 (Very appropriate).

The data collection system used in this study included dialogue, literature review, documentation studies, and questionnaires. Interviews were conducted by researchers in the form of questions and answers directly with informants who acted as informants to obtain the data needed in the research. Documentation study is a data collection technique in which researchers collect and study the necessary information or data through important documents available. Questionnaires or questionnaires are data collection techniques that present several questions or written statements to be answered by respondents.

Data analysis techniques consisted of validity analysis and practicality analysis. The validity of the product developed is obtained using the formula:

$$\bar{T}_v = \frac{\sum_{i=1}^{n} \bar{V}_i}{n}$$

Information:

$\bar{T}_v$: average total validity

$\bar{V}_i$: average validity by the validators

n : many validators

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Table 1. Validity Criteria

Interval	Criteria
$3,25 \leq \bar{T}_v \leq 4,00$	Very Valid
$2,50 \leq \bar{T}_v < 3,25$	Valid
$1,75 \leq \bar{T}_v < 2,50$	Less Valid
$1,00 \leq \bar{T}_v < 1,75$	Invalid

The learning tools are valid if the average total validity score is 2.50. The practicality of the developed product is obtained from the analysis of student response questionnaire data using the formula:

$$\bar{T}_p = \frac{\sum_{i=1}^{n} \bar{P}_i}{n}$$

Information:

$\bar{T}_p$: average total practicality

$\bar{P}_i$: average practicality by the practitioners

n : many practitioners

Table 2. Practicality Criteria

Interval	Criteria
$3,25 \leq \bar{T}_p \leq 4,00$	Very Practical
$2,50 \leq T_p < 3,25$	Practical
$1,75 \leq T_p < 2,50$	Less Practical
$1,00 \leq \bar{T}_p < 1,75$	Impractical

Learning tools are considered practical if the average practicality score is at least 2.50.

RESULTS AND DISCUSSION

This study produced mathematics learning tools (syllabus, RPP, and LKPD) based on discovery learning on geometry flat-side material to facilitate the mathematical understanding abilities of 8th junior high school who get a valid and practical category. The development model used in this development research is a 4-D model consisting of four stages: define, design, development, and disseminate. The results obtained from each of these stages are as follows.

1. Define

At this stage, the first activity carried out is the initial-end analysis. This research was initiated from the importance of students' mathematical understanding abilities, similar to one of the objectives of learning mathematics in Curriculum 13, namely understanding mathematical concepts. However, [6] revealed that junior high school students' mathematical understanding abilities were still low due to a lack of emphasis on students' concepts and students not used to working on non-routine questions. Based on documentation studies and interviews with junior high school mathematics teachers, it was found that the syllabus and lesson plans made by teachers did not fully refer to Permendikbud Number 22 of 2016. Teachers also did not use worksheets in learning.

Furthermore, student analysis was carried out to examine the characteristics of junior high school students. The learning tools developed are intended for 8th-grade junior high school students (12-14 years). According to Piaget, students aged 11-15 years begin to enter the formal operational stage. At this stage, students have started to be able to think abstractly, reason logically, and conclude (Ramdani, 2014).

In concept analysis, the researcher compiled flat-sided geometric material referring to the basic competency (KD) of 8th-grade junior high school mathematics listed in Permendikbud Number 37 of 2018, namely KD 3.9 Distinguishing and determining the surface area and volume of geometry flat-side (cubes, beams, prisms, and pyramids) and KD 4.9 Solve problems related to the surface area and volume of geometry flat-side (cubes, blocks, prisms, and pyramids), and their combinations. Task analysis is carried out to determine competency achievement indicators (IPK) and formulate learning objectives.

2. Design

Learning tools design is carried out according to the format that has been made based on Permendikbud Number 22 of 2016 and contains the stages of the discovery learning model and scientific approach. A validity instrument was also designed at this stage, including a validation sheet and a student response questionnaire. The designed syllabus contains the following components: (1) identity, which includes the name of the educational unit, subject, class/semester, subject matter, and overall time allotment; (2) core competencies; (3) basic competence; (4) learning materials; (5) competency achievement indicators; (6) learning activities; (7) assessment; (8) time allocation for each learning material; and (9) learning resources.

The designed RPP contains the following components: (1) identity of the educational unit; (2) core competencies; (3) base competency and achievement indicators; (4) learning objectives; (5) learning materials; (6) models, approaches, and learning methods; (7) media, tools/materials, and learning resources; (8) learning activities; and (9) assessment.

LKPD is designed based on RPP using a discovery learning model and scientific approach. LKPD consists of the cover section, the contents of the LKPD, which contains activities prepared by applying the discovery learning model and scientific approach, and the final part is in the form of practice questions.

3. Development

At this stage, the design of learning tools that have been developed is then validated and tested. The syllabus, RPP, and LKPD were validated by three validators who were lecturers in mathematics education, and a one-to-one evaluation was carried out on LKPD. The validation results by the three validators can be seen in Table 3, Table 4, and Table 5.

Table 3. Syllabus Validation Result Data

Assessment Aspects	Average	Criteria
Identity and Syllabus Components	4,00	Very Valid
Core Competencies and Basic Competencies	4,00	Very Valid
Learning materials	3,83	Very Valid
Competency Achievement Indicator (IPK)	3,89	Very Valid
Learning Activities	3,50	Very Valid
Assessment	4,00	Very Valid
Time Allocation	4,00	Very Valid
Learning Resources	3,83	Very Valid
Total Average	3,93	Very Valid

Based on Table 3, the total validation average score is 3.93, meaning the syllabus met the valid category. The researcher did not revise the syllabus because the validator did not provide comments and suggestions on the syllabus being developed. Based on the syllabus validation results data, the syllabus is declared fit for testing without revision.

Table 4. RPP Validation Result Data

Assessment Aspects	Average	Criteria
RPP Identity and Components	4,00	Very Valid
Competency Achievement Indicator (IPK)	3,83	Very Valid
Learning objectives	3,89	Very Valid
Learning materials	3,78	Very Valid
Models, Approaches, and Learning Methods	3,71	Very Valid
Media, Tools/Materials, and Learning Resources	3,54	Very Valid
Learning Activities	3,86	Very Valid
Assessment	3,78	Very Valid
Total Average	3,86	Very Valid

Based on Table 4, the average score for each aspect assessed in the RPP suits the very valid criteria. The average result of the total validation of RPP-1 is 3.83, RPP-2 is 3.85, RPP-3 is 3.88, and RPP-4 is 3.90. Overall the average score of the RPP validation results is 3.86, with very valid criteria.

Table 5. LKPD Validation Result Data

Assessment Aspects	Average	Criteria
LKPD cover	4,00	Very Valid
Learning materials	3,83	Very Valid
Learning Activities	3,75	Very Valid
Activities on the LKPD DL Model and Scientific Approach	3,87	Very Valid
Activities at LKPD Facilitating KPM	3,44	Very Valid
Didactic Terms	3,72	Very Valid
Construction Terms	3,79	Very Valid
Technical Requirements	3,82	Very Valid
Total Average	3,80	Very Valid

Based on Table 5, the average score for each aspect assessed on the LKPD is suitable with very valid criteria. The average result of the total validation of LKPD-1 is 3.76, LKPD-2 is 3.81, LKPD-3 is 3.82, and LKPD-4 is 3.80. Overall the average score of LKPD validation results is 3.80, with very valid criteria.

In line with the validation of learning tools, a one-on-one evaluation was also carried out to see the legibility of the developed LKPD. The one-on-one evaluation was carried out on three grade IX students of SMPN 4 Tambang with heterogeneous abilities based on the suggestion from the mathematics teacher. The results of the one-to-one evaluation show that the readability level of the developed LKPD is good because students can work on and understand the activities on the LKPD, even though students still have a little difficulty solving problems.

LKPD, validly tested on small groups, was conducted on six students, and large group trials were conducted on 25 grade VIII students of SMPN 4 Tambang with heterogeneous abilities. This trial was carried out to see LKPD's practicality by students. After the students worked on each LKPD, the researcher gave a response questionnaire to the students. The results of the student response questionnaire on the use of LKPD can be seen in Table 6 and Table 7.

Table 6. Data on Student Response Questionnaire Results in Small Group Trials

Assessment Aspects	Average	Criteria
LKPD display	3,67	Very Practical
Fill in the LKPD	3,50	Very Practical
Ease of Use of LKPD	3,63	Very Practical
Total Average	3,61	Very Practical

Table 6 shows that six students' total average score of LKPD practicality was 3.61 with very practical criteria.

Table 7. Data on Student Response Questionnaire Results in Large Group Trials

Assessment Aspects	Average	Criteria
LKPD display	3,68	Very Practical
Fill in the LKPD	3,35	Very Practical
Ease of Use of LKPD	3,57	Very Practical
Total Average	3,53	Very Practical

Based on Table 7, the total average score of LKPD practicality by 25 students is 3.53, with very practical criteria. In this way, based on the comes about of the approval of syllabus, lesson plans, and worksheets, as well as the comes about of understudy reaction surveys to the utilization of worksheets in little bunch trials and expansive bunch trials, it can be concluded that science learning instruments based on revelation learning show on geometry flat-side fabric to encourage the numerical understanding capacities of 8^{th} review understudies of junior tall school have satisfied the substantial and commonsense necessities.

4. Disseminate

At this stage, the activities carried out are packaging learning tools that have met the valid and practical requirements in book form and publishing articles in national journals. Product packaging is presented in Figure 1.

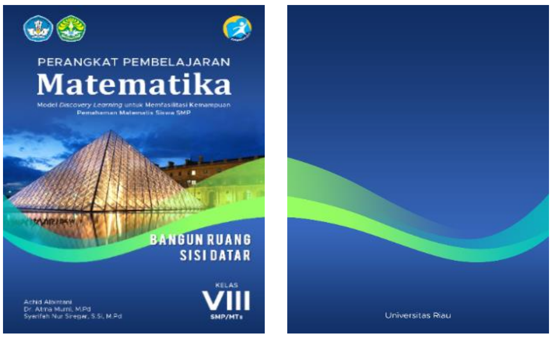

Figure 1. Product Packaging

Based on the results of the LKPD analysis carried out by students in small group trials and large group trials, the researcher found that at stage stimulation and problem statement, students can understand the problem well, can write down things that are known and asked and can write temporary answers to the problems presented. At stage data collecting, students can restate the concepts they have learned, choose and use certain procedures, and relate various concepts to find the formula for a flat side shape's surface area and volume. At stage data processing, the result is that some students still have difficulty solving the problems presented in the LKPD. This is because students are not used to solving non-routine questions. In this case, the researcher guides students to solve these problems. At stage verification, students have been able to re-examine and associate temporary answers made previously with the results of problem-solving. At stage generalization, students have been able to conclude the results obtained from working on the LKPD.

Overall, students work on LKPD was carried out well, and students actively discussed and asked researchers if they experienced difficulties while working on LKPD. This aligns with what was stated by [16] that the model discovery learning would provide opportunities for each student to take an active role in learning and can help form effective teamwork. By implementing model discovery learning, students are directed to find concepts with their thinking skills to develop their mathematical understanding abilities [3].

CONCLUSIONS AND SUGGESTIONS

This development research produces products in mathematics learning tools, including syllabus, RPP, and LKPD based discovery learning models on geometry flat-side material. The development procedure used in this study is a 4-D model consisting of four stages: Define, Design, Development, and Disseminate. At the defined level, the activities carried out were beginning-end analysis, student analysis, concept analysis, task analysis, and formulation of learning objectives. At stage design, the activities are designing learning tools and designing validity and practicality instruments. At the stage of development, validation of learning tools, one-on-one evaluation, and small and large group trials were carried out. At this stage, disseminate done packaging learning tools in book form and publish articles in national journals. This study found that the mathematics learning tool bases the discovery learning model on the geometry flat-side material to facilitate the mathematical understanding abilities of junior high school students have the valid and practical category completely.

REFERENCE

[1] M. D. Siagian, "Kemampuan Koneksi Matematik dalam Pembelajaran Matematika," *MES: Journal of Mathematics Education and Science,* vol. 2, no. 1, pp. 58-67, 2016.

[2] S. Sunismi, "Pengembangan Bahan Ajar Geometri dan Pengukuran Berbasis Realistic Mathematics Education (RME) untuk Siswa SMP Kelas VIII," *Jurnal Pendidikan Matematika (JPM),* vol. 1, no. 1, pp. 1-14, 2015.

[3] S. Mawaddah and R. Maryanti, "Kemampuan Pemahaman Konsep Matematis Siswa SMP dalam Pembelajaran Menggunakan Model Penemuan Terbimbing (Discovery Learning)," *Edu-Mat: Jurnal Pendidikan Matematika,* vol. 4, no. 1, pp. 76-85, 2016.

[4] E. Widyastuti, "Peningkatan Kemampuan Pemahaman Konsep dan Komunikasi Matematis Siswa dengan Menggunakan Pembelajaran Kooperatif Tipe Jigsaw," *AlphaMath: Journal of Mathematics Education,* vol. 1, no. 1, pp. 1-14, 2015.

[5] S. Hartati, I. Abdullah and S. Haji, "Pengaruh Kemampuan Pemahaman Konsep, Kemampuan Komunikasi dan Koneksi Terhadap Kemampuan Pemecahan Masalah," *MUST: Journal of Mathematics Education, Science and Technology,* vol. 2, no. 1, pp. 43-72, 2017.

[6] C. F. Yani, Maimunah, Y. Roza, A. Murni and Z. Daim, "Analisis Kemampuan Pemahaman Matematis Siswa pada Materi Bangun Ruang Sisi Lengkung," *Mosharafa: Jurnal Pendidikan Matematika,* vol. 8, no. 2, pp. 203-214, 2019.

[7] Y. Pamungkas and E. A. Afriansyah, "Aptitude Treatment Interaction terhadap Kemampuan Pemahaman Matematis Siswa," *Jurnal Pendidikan Matematika RAFA,* vol. 3, no. 1, pp. 122-130, 2017.

[8] R. Tianingrum and H. N. Sopiany, "Analisis Kemampuan Pemahaman Matematis Siswa SMP pada Materi Bangun Ruang Sisi Datar," in *Prosiding Seminar Nasional Matematika dan Pendidikan Matematika*, Karawang, 2017.

[9] A. Mulyani, E. K. N. Indah and A. P. Satria, "Analisis Kemampuan Pemahaman Matematis Siswa SMP pada Materi Bentuk Aljabar," *Mosharafa: Jurnal Pendidikan Matematika,* vol. 7, no. 2, pp. 251-262, 2018.

[10] M. S. Fahlevi and L. S. Zanthy, "Analisis Kesulitan Siswa dalam Menyelesaikan Soal Uraian pada Materi Bangun Ruang Sisi Datar," *Jurnal Pembelajaran Matematika Inovatif,* vol. 3, no. 4, pp. 313-322, 2020.

[11] G. Nursyamsiah, S. Savitri, D. N. Yuspriyati and L. S. Zanthy, "Analisis Kesulitan Siswa SMP Kelas VIII dalam Menyelesaikan Soal Materi Bangun Ruang Sisi Datar," *MAJU: Jurnal Ilmiah Pendidikan Matematika,* vol. 7, no. 1, pp. 98-102, 2020.

[12] M. Munir and A. Mahmudi, "Pengembangan Perangkat Pembelajaran Geometri SMP dengan Pembelajaran Berbasis Masalah," *Jurnal Riset Pendidikan Matematika,* vol. 5, no. 2, pp. 147-158, 2018.

[13] E. Susanto and H. Retnawati, "Perangkat Pembelajaran Matematika Bercirikan PBL untuk Mengembangkan HOTS Siswa SMA," *Jurnal Riset Pendidikan Matematika,* vol. 3, no. 2, pp. 189-197, 2016.

[14] L. Moreno, "Penerapan Model Discovery Learning untuk Meningkatkan Kemampuan Pemahaman Matematis Siswa Kelas VII SMPN 25 Pekanbaru," *Jurnal Pendidikan Tambusai,* vol. 2, no. 6, pp. 1401-1428, 2018.

[15] K. Yuliani and S. Saragih, "The Development of Learning Devices Based Guided Discovery Model to Improve Understanding Concept and Critical Thinking Mathematically Ability of Students at Islamic Junior High School of Medan," *Journal of Education and Practice,* vol. 6, no. 24, pp. 116-128, 2015.

[16] D. P. Hutami and Y. Wiyatmo, "Pengembangan Perangkat Pembelajaran Berbasis Guided Discovery Learning untuk Meningkatkan Pemahaman Konsep dan Kemampuan Kerjasama Peserta Didik," *E-Journal Pendidikan Fisika,* vol. 7, no. 1, pp. 18-28, 2018.

[17] Y. I. Wulandari, Sunarto and S. A. Totalia, "Implementasi Model Discovery Learning dengan Pendekatan Saintifik untuk Meningkatkan Kemampuan Berfikir Kritis dan Hasil Belajar Siswa Mata Pelajaran Ekonomi Kelas XI IIS I SMA Negeri 6 Surakarta TA. 2014/2015," *Jurnal Pendidikan Bisnis dan Ekonomi,* vol. 1, no. 2, pp. 1-21, 2016.

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