GROUP INVESTIGATION-BASED "AT-WORKSHEET" TO IMPROVE STUDENTS' ABSTRACTION ABILITY

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Abstract

The abstraction process will describe an activity that will lead to concept formation. Abstraction ability is one of the goals in understanding mathematical concepts. Based on the results of observations and interviews with mathematics teachers at SMPN 1 Kebonsari, the learning results of VIII grade students in doing math problems show that there are still many students who have not been able to apply concepts in solving problems. Meanwhile, The learning process in class still applies the lecture method and there is no innovation in teaching materials for learning. The purpose of this research is to produce a Pythagorean theorem LKPD that contains a summary of material, example problems, and structured problems supported by attractive images and designs called AT-Worksheet with the Group Investigation learning model as one of the solutions students can improve their abstraction skills in learning mathematics. This research uses the Research and Development (R&D) research method with the ADDIE development model. The results of this study are valid and very practical AT-Worksheet. The validation results obtained a percentage of 85.00% and met the valid criteria. The results of students response questionnaire obtained a percentage of 82.07% and meet the criteria of very practical, so that the AT-Worksheet can be used in mathematics learning to escalate the abstraction ability of VIII class students of SMPN 1 Kebonsari.

Keywords: abstraction ability; AT-Worksheet; Group Investigation.

Abstrak

Proses abstraksi akan menggambarkan sebuah aktivitas yang akan mengarahkan ke pembentukan konsep. Kemampuan abstraksi menjadi salah satu tujuan dalam memahami konsep-konsep matematika. Berdasarkan hasil observasi dan wawancara dengan guru matematika SMPN 1 Kebonsari bahwa hasil belajar siswa kelas VIII dalam mengerjakan soal matematika terlihat masih banyak siswa yang belum mampu mengaplikasikan konsep dalam menyelesaikan soal. Sedangkan proses pembelajaran di kelas masih menerapkan metode ceramah dan belum ada inovasi bahan ajar untuk pembelajaran. Tujuan penelitian ini ialah menghasilkan LKPD yang memuat ringkasan materi, contoh soal, dan soal-soal terstruktur terstruktur yang didukung dengan gambar dan desain yang menarik yang diberi nama AT-*Worksheet* dengan model pembelajaran *Group Investigation* sebagai salah satu solusi siswa dapat meningkatkan kemampuan abstraksinya dalam belajar matematika. Penelitian ini menggunakan metode penelitian Research and Development (R&D) dengan model pengembangan ADDIE. Hasil penelitian ini ialah AT-*Worksheet* yang valid dan sangat praktis. Hasil validasi diperoleh persentase sebesar 85,00% dan memenuhi kriteria valid. Hasil angket respon siswa diperoleh presentase sebesar 82,07% dan memenuhi kriteria sangat praktis, sehingga AT-*Worksheet* bisa dimanfaatkan dalam pembelajaran matematika untuk meningkatkan kemampuan abstraksi siswa kelas VIII SMPN 1 Kebonsari.

Kata kunci: AT-*Worksheet*; *Group Investigation*; kemampuan abstraksi.

INTRODUCTION

Abstraction is a basic process in mathematics. The usual process uses an inductive way of identifying and deriving a pattern. The abstraction process will describe an activity that will lead to concept formation (Warsito, Saleh, & Sukirwan, 2020). Abstraction is a construction process by determining and changing the relationship between mathematical objects into new concepts without mathematical objects (Yilmaz & Argun, 2018).

Unstructured mathematics and mathematical concepts that relate to life, so that students are able to think abstractly and develop problems in everyday life (Nihayah, 2021). Students need to have the ability to understand concepts, namely abstraction ability. Abstraction ability is the ability to build relationships between objects that are independent of mathematical objects into new concepts by classifying previous objects and thinking symbolically in solving abstract problems (Sitihanifah & Ramlah, 2021; Yilmaz & Argun, 2018). The ability of mathematical abstraction is being able to connect mathematical concepts through a generalization process so that it is able to produce new concepts (Komala, 2018). Abstraction ability is one of the goals in understanding mathematical concepts. Abstraction ability is one of the goals in understanding mathematical concepts. The ability to think abstraction is needed by students in learning mathematics, because it is related to the need for students to find ways to solve problems without real problem objects (Sugandi, Linda, & Bernard, 2020). The ability of students in Indonesia is still in the Lower-Order Thinking Skills category, where the thinking ability of students in Indonesia is still at a low level (Sitihanifah & Ramlah, 2021).

Based on the learning results of SMPN 1 Kebonsari students, it shows that more than 50% of students are still not capable to correctly solve the problems given. Most students have not been able to identify problems into mathematical concepts. Some students still have difficulty understanding story problems. This is evidenced by the results of an interview with one of the math teachers at SMPN 1 Kebonsari that with the lecture method learning process only 1/3 of the number of students in one class who are able to find problems if given a story problem. Teachers only provide knowledge to students, so students are not given the opportunity to develop their own knowledge (Ayuwanti, 2017). Teachers are still the center of student learning resources (teacher centered). This can cause students to become bored and even students become uninterested in the subject, especially mathematics. A learning model that involves students in the learning process (Student Center Learning) is needed to produce active learning (Nainggolan, Tanjung, & Simarmata, 2021). Teachers are able to apply the Group Investigation (GI) learning model as an effort to create an active classroom atmosphere so that students are not bored with learning in class.

Group Investigation (GI) is a cooperative learning model that encourages students to solve problems by working together in groups (Assalam, Sriyono, & Nurhidayati, 2020; Sojayapan & Khlaisang, 2020). The Group Investigation (GI) learning model is often called the most complex learning model in learning. The Group Investigation (GI) model involves students from determining the topic to how to learn it by investigating (Ayuwanti, 2017).

Group Investigation (GI) learning model can be applied by using LKPD. The use of LKPD can involve students actively in learning and be able to find concepts through their own constructions (Astuti & Setiawan, 2013). Students Worksheet (LKPD) is a teaching material that contains instructtions, a list of tasks, and guidance for doing activities so that it can help students learn (Anggara & Fayeldi, 2018). LKPD is one of the learning tools as a means of supporting the learning process.

Based on the above problems, researchers developed AT-Worksheet is an LKPD based on Group Investigation (GI) to improve students' abstraction skills in learning mathematics. This AT-Worksheet holds a resume of the material, sample questions, and structured questions. The developed AT-Worksheet has valid and practical criteria for use to help improve abstraction skills.

RESEARCH METHODS

The research method used is R&D (Research and Development). This research developed an LPKD in the form of AT-Worksheet using Group Investigation (GI) model to incrase the abstraction abilities of class VIII students of SMPN 1 Kebonsari on Pythagoras material. The subjects in this research were students in class VIII E of SMPN 1 Kebonsari totaling 30 students.

The development model in this research is ADDIE. The ADDIE model has 5 stages (Cahyadi, 2019). The 5 stage are (1) analysis stage by analyzing the curriculum, teaching materials, mate-rials, learning models, and abstraction abilities of SMPN 1 Kebonsari students; (2) design stage by preparing research instruments, selecting learning models, and initial design of

AT-Worksheet products; (3) development stage by validating AT-Worksheet by validators to obtain assessments and input as product improvements; (4) implementation stage by implementing the product by conducting limited trials and field trials. (5) evaluation stage by analyzing the data obtained from the implementation stage of the developed product.
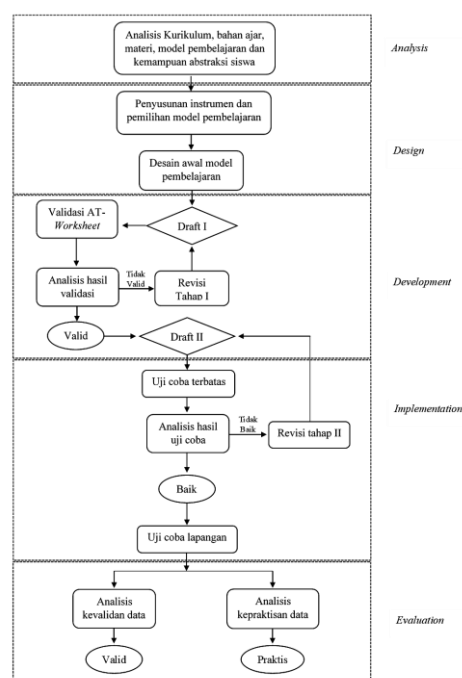

Figure 1. Flow of Research and Development

Data collection techniques in this research are observation, product validation and student responses after using the product. Data collection instruments used were observation sheets, validation sheets, and student response questionnaires. Observation sheets to find out the situation and conditions of learning mathematics at school as a basis for product development, validation sheets to see the validity of the products developed, and questionnaires given to students to see the practicality of the products developed.

AT-Worksheet based Group Investigation data processing technique uses product validity analysis and learning implementation data processing uses practicality analysis obtained from student response questionnaires.

a. Product Validity Analysis Technique

AT-Worksheet is the product that will be validated. The validation assessment was carried out by 2 mathematics teachers at SMPN 1 Kebonsari as validators. Then the data obtained from the validators is analyzed to determine the validity of the AT-Worksheet. The validity analysis can be calculated using the following formula:

$$V = \frac{TSe}{TSh} \times 100\% \qquad (1)$$

Information:
V = Validation percentage
TSe = Total empirical score
TSh = Total expected score
The analysis formula for combining combined validation calculations is as follows:

$$v = \frac{vah1 + val2 + vah3}{3} sug \qquad (2)$$

Table 1. Validity Criteria

Validity Criteria	Validity Level
85,02% - 100,00%	Very valid
70,01% - 85,00%	Valid
50,01% - 70,00%	Less valid
01,00% - 50,00%	Invalid

Source: (Akbar, 2013)

Researchers referred to the validity criteria in Table 1 and set the validity criteria as the minimum limit of AT-Worksheet validity in the range of 70.01% - 85.00%.

b. Practicality Analysis Technique
The data used for practicality analysis was obtained from student response questionnaires. Practicality analysis can be calculated using the following formula:

$$V_p = \frac{TSEp}{S-max} \times 100\% \qquad (3)$$

Information:
Vp = Practicality Validation
$TSEp$ = Total practicality empirical score
$S - max$ = Maximum expected score

Table 2. Practicality Criteria

Practicality Criteria	Practicality Level
75,01%-100%	Very Practical
50,01%-75,00%	Practical
25,01%-50,00%	Less Practical
00,00%-25,00%	Impractical

Source: (Akbar, 2013)

The researcher refers to the practicality criteria in Table 2 and sets a minimum limit for practicality criteria ≥ 50.01%.

RESULTS AND DISCUSSION

The results of this development research are AT-Worksheet based on Group Investigation which is valid and very practical in improving the abstraction ability of SMPN 1 Kebonsari students which will be described in detail as follows.

1. **Analysis Stage**
The results of this development research analysis are described as follows.

a. **Curriculum Analysis**
Researchers reviewed the applicable curriculum at SMPN 1 Kebonsari for class VIII applying the 2013 Curriculum and analyzed the core competencies and basic competencies as a reference in designing the AT-Worksheet to be developed.

b. Analysis of Teaching Materials

Analysis of teaching materials needs to be done as the basis for the product to be developed. The selection of LKPD is to help foster student enthusiasm in learning the material and improve students' abstraction abilities.

c. Material Analysis

Based on the results of learning mathematics, VIII grade students still have difficulty understanding and solving it. The material used is related to student difficulties and in accordance with the semester taken in semester 2, namely pythagoras. The material chosen is in accordance with the results of interviews with mathematics teachers.

d. Learning Model Analysis

The learning model used by SMPN 1 Kebonsari teachers tends to make students only listen to explanations of material from the teacher without being required to find material concepts independently. The impact of the learning model will create a lack of effort to improve students' abstraction skills in mathematics learning.

e. Analysis of Students' Abstraction Ability

The mathematics learning outcomes for class VIII students at SMPN 1 Kebonsari are still relatively low. According to the results of interviews with VIII grade teachers, this shows a lack of innovative teaching materials so that students' abstraction skills are still not optimal in learning mathematics. This is known from the lack of enthusiasm students in learning math.

2. Design Stage

The design stage includes prepararing instruments and the selecting learning models. Description of activities on design stage is as follows.

a. Instrument Preparation

The instruments in this research are described as follows.

1) Instrument Validation Sheet

Instrument validation sheet is used to validate learning instruments. The instruments validated by the validator are student response questionnaires and learning outcomes test questions.

2) Group Investigastion Based AT-Worksheet Validation Sheet

The Group Investigation based AT-Worksheet validation sheet that has been prepared contains 5 components, namely the content feasibility component, the linguistic feasibility component, the presentation feasibility component, the graphic component, and the LKPD (AT-Worksheet) characteristic component. The validation sheet prepared uses a Likert scale which has a choice of scores from 1 to 5 with a score of 5: very good, score 4: good, score 3: quite good, score 2: not good, score 1: very bad.

3) Student Response Questionnaire Sheet Class VIII

The student response questionnaire sheet is used to determine the practicality of the product developed. Students response questionnaire sheet has 10 statement items consisting of 5 negative statements and 5 positive statements. Students are asked to fill in the questionnaire sheet by giving a check mark ($\sqrt{}$) in one of the answer columns consisting of strongly agree (S), agree (S), neutral (N), disagree (TS), and strongly disagree (STS) columns.

b. Selection of Teaching Materials and Learning Models

Based on the results of the analysis activities that have been carried

out, researchers developed AT-Worksheet as LKPD based on the Group Investigation (GI). Selection of AT-Worksheet based on Group Investigation is due to the relatively low abstraction ability of students in grade VIII of SMPN 1 Kebonsari and still use conventional learning models in the learning process. Group Investigation based AT-Worksheet can help students develop their abstraction skills by following the activities on the AT-Worksheet, including let's observe, let's understand, let's find information, let's think, let's share, and let's investigate problems in groups. The activities in the Group Investigation based AT-Worksheet guide students to discover

and apply material concepts related to the Pythagorean theorem independently.

c. Preliminary Design of Group Investigation Based AT-Worksheet

At this stage, researchers compiled and designed the content on the Group Investigation based AT-Worksheet. The AT-Worksheet was developed based on the basic competencies and indicators of competency achievement on the Pythagorean theorem material. The AT-Worksheet was designed with structured Group Investigation learning steps to improve junior high school students' abstraction skills. The AT-Worksheet design looks like Figure 2.
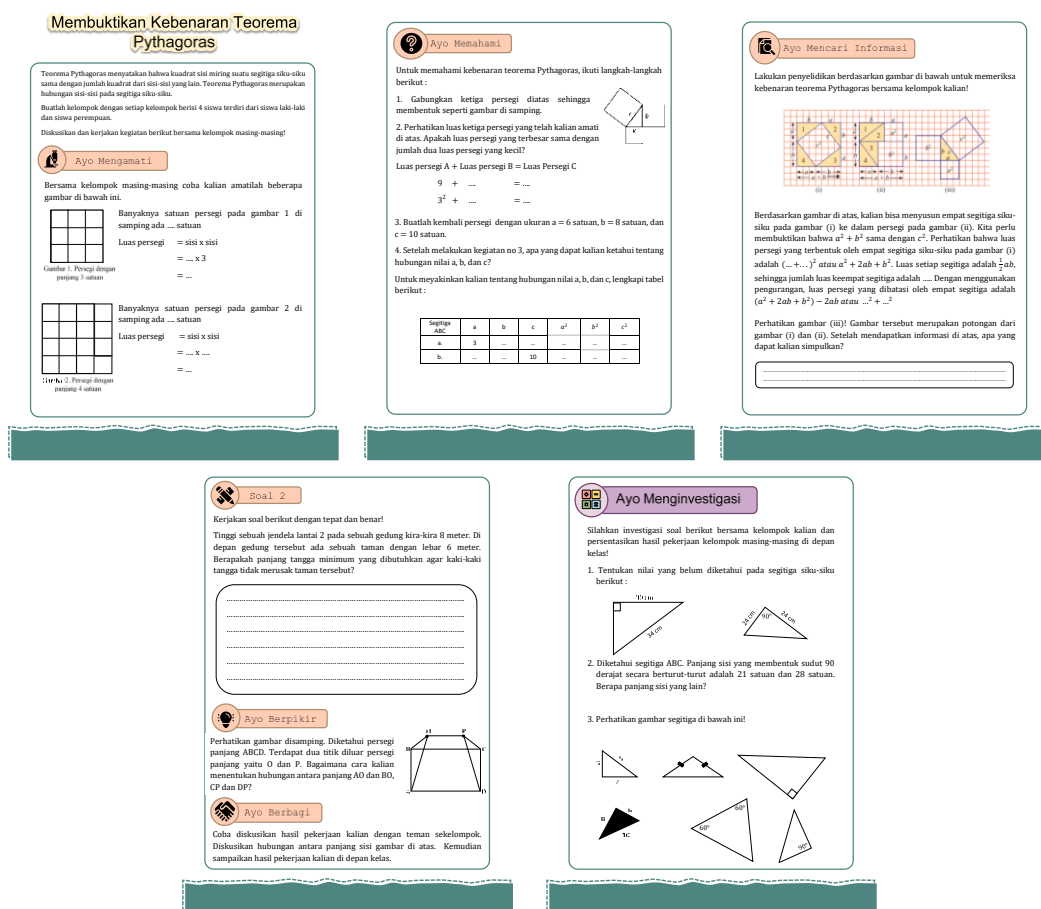

Figure 2. AT-Worksheet Content Design

3. Development Stage

Activities at the development stage are described as follows.

a. Validation of Group Investigation Based AT-Worksheet and Research Instruments

Validation of Group Investigation based AT-Worksheet and research instruments aims to determine whether the Group Investigation based AT-Worksheet developed and the research instruments used obtain valid criteria. Validation in this study was carried out by two validators. The results of the validation of AT-Worksheet based on Group Investigation research instruments are presented as follows.

a) Results of the Group Investigation Based AT-Worksheet Validation Test

Table 3. Results of AT-Worksheet Validation

Validation Results	Validator	
	I	II
TSe	93	94
TSh	110	110
Validation Presentation	84,55%	85,45%
Combined Presentation	85,00%	

Based on the data from the validation of the AT-Worksheet by the two validators, the results of validator I obtained a score of 93 with a validity percentage of 84.55% and validator II obtained a score of 94 with a validity percentage of 85.45%. The results of the combined average percentage of the two validators of 85.00% can be categorized in the criteria "valid" so that the AT-Worksheet is suitable for testing with minor revisions.

b) Results of Student Response Questionnaire Validation

Table 4. Validation result of student's response questionnaire

Validation Results	Validator	
	I	II
TSe	22	23
TSh	25	25
Validation Presentation	88,00%	92,00%
Combined Presentation	90,00%	

Based on the data analysis of the validation of the student response questionnaire sheet, the validation percentage is 90.00%. According to Akbar (2013) explains that the percentage of 90.00% includes very valid criteria. The student response questionnaire sheet can be used without revision to determine the practicality of the Group Investigation based AT-Worksheet.

4. Implementation Stage

Based on the validation results obtained, the AT-Worksheet is feasible to be tested. At this stage, limited trials and field trials were conducted.

1) Limited Trial

The limited trial of AT-Worksheet based on Group Investigation involved 10 respondents from class VIII C students of SMPN 1 Kebonsari. Researchers applied the Group Investigation based AT-Worksheet in the learning process. The researchers explained the steps of learning with AT-Worksheet based on Group Investigation. Students in groups will find and apply the concept of Pythagorean theorem material by applying AT-Worksheet based on Group Investigation. The application of AT-Worksheet based on Group Investigation can develop abstraction skills in identifying problems related to the Pythagorean theorem and formulating a

solution strategy. Students also develop communication skills through group cooperation and present the results of discussions and investigations through presentations. Students present the results of the problem investigation on the Group Investigation based AT-Worksheet in front of the class then conduct an evaluation with the teacher and students.

Students fill out a student response questionnaire after carrying out learning activities by applying AT-Worksheet to measure the level of practicality of AT-Worksheet. The practicality of the Group Investigation based AT-Worksheet was obtained based on the analysis of the results of the student response questionnaire that had participated in the limited trial.

Table 5. Limited trial practicality test results

Practical AT-Worksheet based on Group Investigation	
Combained T-Sep	401
Combained S-Max	500
Combained Presentation	80,20%

The results of the practicality data analysis show that what was developed Group Investigation based AT-Worksheet obtained a practicality percentage of 80.20%. Akbar (2013) shows that the percentage of 80.20% is classified as very practical. Results of the practicality data analysis indicate that Group Investigation based AT-Worksheet is practical for use by students of class VIII C SMPN 1 Kebonsari.

2) Field Trial

After analyzing the data from the limited trial, a field trial was then conducted. The field trial in this study consisted of 30 students of class VIII E SMPN 1 Kebonsari. The treatment in the field trial was the same as in the limited trial.

Table 6. Field trial practicality test results

Practical AT-Worksheet based on Group Investigation	
Combained T-Sep	1231
Combained S-Max	1500
Combained Presentation	82,07%

The results of the student response questionnaire analysis showed a percentage of 82.07%. According to Akbar (2013) with a percentage of 82.07% including a very practical category. This shows that AT-Worksheet gets a positive response so that it can be said that AT-Worksheet is practically used in learning mathematics, especially in the subject of the Pythagorean theorem.

5. Evaluation Stage

At the evaluation stage, the quality of AT-Worksheet based on Group Investigation is analyzed to escalate the abstraction abilities of junior high school students. The results of the analysis will be described as follows.

a. Analysis of the validity of Group Investigation Based AT-Worksheet

The results of the validation analysis of the Group Investigation based AT-Worksheet obtained validity from the first validator of 84.55% and the second validator of 85.45%, so a combined percentage score of 85.00% was obtained, so it was included in the "valid" criteria. According to Akbar

(2013) the validity of 85.00% is included in the moderately valid category. The Group Investigation learning model affects the development of concept understanding and problem solving skills (Mendrofa, 2018). This is in line with the research of Asmaranti & Pratama (2013) that the design of LPKD with a learning model will help students find a concept as well as help apply the concepts found. According to Nurhasanah, Kusumah, & Sabandar (2017) the indicator of abstraction ability is by applying concepts according to context.

b. Analysis of the Practicality of Group Investigation Based AT-Worksheet

The practicality of the Group Investigation based AT-Worksheet was obtained through filling out the response questionnaire of VIII C and VIII E class students to the developed AT-Worksheet. The percentage of practicality obtained from student responses through response question-naires in limited trials was 80.20% and in field trials was 82.07%. According to Akbar (2013) the percentage of student responses obtained from the Group Investigation based AT-Worksheet in limited trials and field trials is included in very practical criteria. LKPD designed with colors that attract students' attention as well as images and illustrations on LKPD help students understand the material about the pythagorean theorem (Revita, 2019). The developed LKPD is feasible to use which involves active students in learning and being able to find concepts through their own constructions (Astuti & Setiawan, 2013). According to Adelia, Susanti, Sari, & Simarmata (2020) abstraction ability allows to construct concepts according to students' minds. Based on the results

obtained, the Group Investigation based AT-Worksheet on Pythagorean theorem material is declared "very practical" to be used in the learning process.

The validator's assessment of the AT-Worksheet obtained valid results, which obtained an average score of 85%. This shows that the AT-Worksheet that has been developed is in accordance with the elements of LKPD. This AT-Worksheet is very material because the content of the material displayed in it is in accordance with the competency standards, core competencies, basic competencies, and learning objectives. This AT-Worksheet also uses proper Indonesian language in accordance with correct grammar rules, so that students easily understand the language used in the AT-Worksheet. The feasibility of the AT-Worksheet obtained decent results by obtaining a score of 82.07% in the field trial. This AT-Worksheet is stated to be very practical to use in the learning process because the material presented is in accordance with the Group Investigation learning model and is equipped with illustrative images and a colorful and attractive AT-Worksheet design.

Based on these considerations, it is believed that the AT-Worksheet can certainly be used as teaching material in improving the ability to solve mathematical problems and can be used as a reference for teacher assessment of students' abstraction abilities. This is in accordance with previous research which shows that the delivery of interesting material will make it easier for students to understand the meaning contained in the material, so that it can improve higher-level thinking skills (Elly S & Mandasari, 2018).

The advantage of this research is that this learning model encourages the participation of all students in learning.

Students work together to investigate problems and solve solutions through discussion, so they can learn from each other and build understanding together. This model can help students develop their mathematical abstraction skills.

The factors that influence the development of Group Investigation-based AT-Worksheet, among others; 1) presentation of material on AT-Worksheet, 2) attractive AT-Worksheet design, 3) concept suitability; and 4) language use. So that using AT-Worksheet based on Group Investigation will have a good impact on the development of mindset, where students can understand the concept of Pythagoras theorem, students are motivated to learn because it is equipped with pictures and attractive presentation design, so students will think more critically so that students' abstraction ability also increases.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of research by developing AT-Worksheet based on Group Investigation, the validation results of AT-Worksheet are valid with a percentage of 85.00%. Furthermore, the practicality of the AT-Worksheet obtained very practical results with a percentage of 82.07%. AT-Worksheet based on Group Investigation is feasible to use because it has met the criteria of validity and practicality and can help learning activities to escalate the abstraction ability of VIII grade students of SMPN 1 Kebonsari.

Based on the research results, suggestions given to researchers are 1) Group Investigation based AT-Worksheet can be used as a reference for developing further AT-Worksheets, 2) Development of the AT-Worksheet is then used with other materials, 3) AT-

Worksheet based on group investigation can be developed to be even more attractive in terms of appearance and content because the AT-Worksheet that is being developed still has deficiencies and needs to be refined even better.

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