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DEVELOPMENT OF COLLABORATIVE PROBLEM SOLVING-BASED LEARNING TOOLS TO IMPROVE MATHEMATICAL ADAPTIVE REASONING SKILLS

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Abstract

Students' ability to solve mathematical adaptive reasoning problems is still relatively low. As a result, students have difficulty in solving mathematical adaptive reasoning problems. The cause of the low mathematical adaptive reasoning ability of students is the lack of learning tools that facilitate mathematical adaptive reasoning ability. Therefore, a Collaborative Problem Solving-based tool was developed that can stimulate an active learning process, motivate students and improve mathematical adaptive reasoning skills. This research is development research using the Plomp development model. The products developed are lesson plans and worksheets based on Collaborative Problem Solving for class VIII junior high school statistics material. The purpose of this research is to produce Collaborative Problem Solving-based tools that are valid, practical, and effective on the mathematical adaptive reasoning skills of grade VIII junior high school students. The results showed that the learning tools in the form of lesson plans and LKS based on Collaborative Problem Solving for students in grade VIII junior high school were valid, practical, and effective. The results of the validation of the learning tools developed are very valid, adjusting 5 indicators of mathematical adaptive reasoning skills seen from the aspects of making conjectures, providing reasons for the answers given, drawing conclusions from a statement, checking the validity of an argument, and finding patterns from a mathematical problem. The results of the practicality of learning devices are very practical in terms of ease of use, suitability of time allocation, attractiveness and usefulness. Furthermore, it is said to be effective because it has an impact on students' mathematical adaptive reasoning ability of 82.70% with a very good category.

Keywords: Collaborative Problem Solving; learning tools; mathematical adaptive reasoning skills.

Abstrak

Kemampuan peserta didik dalam menyelesaikan masalah penalaran adaptif matematis masih tergolong rendah. Akibatnya, peserta didik mengalami kesulitan dalam menyelesaikan soal penalaran adaptif matematis. Adapun penyebab rendahnya kemampuan penalaran adaptif matematis peserta didik yaitu kurangnya perangkat pembelajaran yang memfasilitasi kemampuan penalaran adaptif matematis. Oleh karena itu, dikembangkan sebuah perangkat berbasis Collaborative Problem Solving yang dapat menstimulus proses pembelajaran aktif, memotivasi peserta didik dan meningkatkan kemampuan penalaran adaptif matematis. Penelitian ini merupakan penelitian pengembangan dengan menggunakan model pengembangan Plomp. Produk yang dikembangkan adalah RPP dan LKS berbasis Collaborative Problem Solving untuk kelas VIII SMP materi statistika. Tujuan dari penelitian ini adalah untuk menghasilkan perangkat berbasis Collaborative Problem Solving yang valid, praktis, dan efektif terhadap kemampuan penalaran adaptif matematis siswa kelas VIII SMP. Hasil penelitian menunjukkan bahwa perangkat pembelajaran berbentuk RPP dan LKS berbasis Collaborative Problem Solving siswa kelas VIII SMP adalah valid, praktis, dan efektif. Hasil validasi perangkat pembelajaran yang dikembangkan sudah sangat valid, menyesuaikan 5 indikator kemampuan penalaran adaptif matematis dilihat dari aspek mengajukan dugaan, memberikan alasan mengenai jawaban yang diberikan, menarik kesimpulan dari sebuah pernyataan, memeriksa kesahihan suatu argumen, dan menemukan pola dari suatu masalah matematika. Hasil praktikalitas perangkat pembelajaran sangat praktis dilihat dari aspek kemudahan penggunaan, kesesuaian alokasi waktu, daya tarik dan kebermanfaatan. Selanjutnya dikatakan efektif karena memberikan dampak terhadap kemampuan penalaran adaptif matematis siswa 82,70% dengan kategori sangat baik.

Kata Kunci: *Collaborative Problem Solving; kemampuan penalaran adaptif matematis; perangkat pembelajaran.*

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INTRODUCTION

The 2013 curriculum was developed using a philosophical foundation, one of which requires the curriculum to have subject names that are the same as the names of disciplines and aims to develop intellectual abilities and academic excellence (Permendikbud, 2013). One of the ways to develop intellectual abilities is by carrying out the learning process in various subjects. One of them is in the subject of mathematics. Mathematics is one of the basic sciences that can develop intellectual abilities. This is in line with (Ningsih, 2016) who argues that school mathematics is one part of mathematics chosen based on educational meaning, namely to be able to develop students' abilities and personalities along with the advancement of science and technology.

The learning process mathematics emphasizes reasoning activities. Mathematics and reasoning are two things that are bound together, with reasoning, in the learning process, students can understand mathematics to be more meaningful and logical (Sholihah, 2018). Five standards of mathematical competence that need to be improved in mathematics learning according to Kilpatrick and Findell (2001), one of which is adaptive reasoning.

According to Kilpatrick, Swafford, & Findell (2001) adaptive reasoning is the ability that students must have to draw a conclusion, estimate an answer, provide an explanation of the concepts that have been given, and can be proven mathematically. Another opinion according to (Wibowo, 2016) states that adaptive reasoning is the ability to think logically about the relationship between concepts and procedures so that it can prove in problem solving and if there are differences of opinion it can be resolved in a reasonable way. Meanwhile, according to (Sholihah, 2018) adaptive reasoning is a mathematical ability to think logically about the relationship between concepts and situations that link the answer with the reasons given. According to (Widjajanti, 2011), the indicators of adaptive reasoning ability are: (1) The ability to make conjecture; (2) The ability to provide reasons or evidence for the truth of a statement; (3) Ability to draw conclusions from a statement; (4) Ability to check the validity of an argument; (5) Ability to find patterns in a mathematical phenomenon.

According to Wibowo (2016), adaptive reasoning is the ability to think logically about the relationship between concepts and procedures so that it can prove in problem solving and if there are differences of opinion it can be resolved in a reasonable way. However, based on the reality in the field based on the results of the preliminary study, it is found that adaptive reasoning skills are still low. This can be seen from each indicator that has not been achieved properly and the average student score of the two questions is only 16.037, meaning that it is still below the Minimum Completion Criteria (KKM). The results of research conducted by (Hasanah, 2018) state that based on the results of the pre-research test which results in that students' adaptive reasoning skills are still low, this can be seen based on the acquisition of the average test score.

One of the factors is due to the limited use of teaching materials in the learning process. According to Barata (2015), through his observation process, it shows that some junior high school teachers, in terms of making lesson plans, prefer a practical way, namely by downloading lesson plans found on the internet rather than compiling them themselves. Meanwhile, based on

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research by (Handayani & Andriani, 2019), the results of question and answer with VIII grade students said that the LKS used by the teacher was less interesting, so there was no interest and motivation in learning mathematics.

This is in line with the results of interviews conducted by researchers with 8th grade mathematics teachers who stated that in the learning process it is rare to use student worksheets and in the learning process the teacher only uses package books provided by the government or package books published by Erlangga. In line with that in research conducted by Sahrul, Yuanita, & Maimunah (2020), teachers said the use of textbooks takes a long time, while having to complete the material on time according to the learning outcomes. This happens because of the lack of teachers' ability to make teaching materials that are in accordance with the needs of students. The lack of teaching materials (especially LKS) causes less support for students in constructing knowledge that leads to adaptive reasoning skills.

Komariah, Suhendri, & Hakim (2018) the results of an interview with one of the mathematics teachers said that the method often used by teachers in the learning process is the conventional method. In addition, according to Barata (2015), the use of conventional methods often displays material that is too abstract, making it difficult for students to understand. This is in line with the situation in one of the middle schools in Kuningan city, where the teacher when carrying out the learning process in the classroom still uses conventional methods that are teacher-centered. Based on the description above, it shows that the use of conventional methods is less effective to be used in the learning process.

To train students' adaptive reasoning skills so that they can increase, good quality teacher-made learning tools must be developed that are in accordance with the characteristics and needs of students to create a conducive, effective and optimal classroom atmosphere so as to achieve the expected learning objectives. According to (Herdiana, Wahyudin, & Sispiyati, 2017), learning tools are important elements to direct the learning process towards achieving the expected competencies. Learning tools that can be developed to overcome these problems are Learning Implementation Plans (RPP) and Student Worksheets (LKS). According to Barata (2015), it is suggested that for teachers in developing lesson plans and student worksheets, it is expected to realize an effective classroom learning process. As for students, the development of learning tools is expected to facilitate understanding of the material provided.

The development of learning tools based on mathematical adaptive reasoning skills in its implementation requires a strategy, one of which is by applying a learning model that involves students sitting in groups so that it can make students more active during the learning process. One of the learning models that can make learning active is the collaborative problem solving model. Rahmat (2019) states that one of the learning models that can make students active in learning is collaborative problem solving because this model is a combination of collaborative and problem-based learning which focuses more on student learning activities in groups, helping and guiding students in difficulty and developing their understanding.

According to Dillenbourg (1999), collaborative problem solving is a learning model that requires cooperation between two or more people with the

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same goal of being able to solve or solve the problems given. (Nelson, 1999) states that collaborative problem solving is a combination of cooperative learning and problem-based learning. These two lessons are expected to create a collaborative learning environment, but not comprehensive. The learning environ-ment is a situation that supports students to collaborate naturally and effectively which is designed so that they can develop knowledge through their own experience.

According to Marlina (2014) argues that collaborative problem solving is a learning model that begins by presenting problems to students that must be done individually and in groups. The steps of collaborative problem solving learning consist of four stages, namely (1) The existence of a problem. (2) Making plans to solve problems individually. (3) Group completion. (4) Transfer of work results (Marlina, 2014). The collaborative problem solving learning model requires teamwork in solving problems armed with the prior knowledge possessed by each student.

According to Nazarudin (Barata, 2015), learning tools are everything that is needed in learning and are prepared by the teacher so that the implementation and evaluation process can be carried out systematically and achieve the desired results, which include effective week analysis, annual program, semester program, syllabus, lesson plans, LKS, evaluation instruments, and KKM. Meanwhile, according to Ja'far, Sunardi, & Kristiana (2014), learning tools are a collection of learning resources used in learning activities by students and teachers. Another opinion according to Yanti, Sumarni, & Adiastuty (2019) that learning tools are a number of tools in the learning process or activities to achieve the desired learning objectives. Development of learning devices, researchers focus on the subject matter of statistics. According to Krisna (2019), the difficulty experienced by students in one of the Catholic junior high schools in Jembrana is solving problems related to story problems (contextual).

This is in line with the results of interviews with researchers at one of the middle schools in Kuningan city that in learning mathematics the difficulties often experienced by class VIII students are solving problems related to contextual problems or daily life problems. While in statistical material the problems presented are contextual problems. This is supported by (Kirana & Nazihah, 2018) who say that statistical material has a connection with everyday life. In addition, based on the results of the interview, the researcher stated that the statistics material had not used student worksheets in the learning process and only relied on the package book.

Research by Handayani (2018) state the results of questions and answers with 8th grade students said that the worksheets used by teachers were less interesting, so there was no interest and motivation in learning math. This is in line with the results of interviews conducted by researchers with 8th grade mathematics teachers who stated that in the learning process they rarely use student worksheets. Based on the explanation above, it provides the fact that the learning tools used in learning have not been developed optimally, meaning that there is no desire from teachers to make their own learning tools that are in accordance with the characteristics of students. This happens because of the lack of teacher ability to make teaching materials that are in accordance with the needs of students. The lack of teaching materials causes less support for students in constructing

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knowledge.

Based on the description above, it can be concluded that the problem is how teachers develop learning tools that can facilitate students in order to produce good quality learning tools. The learning tools developed must be tailored to the characteristics and needs of students. The purpose of developing learning tools is to produce quality learning tools and to create a conducive, effective and optimal classroom atmosphere so as to achieve the expected learning objectives.

METHODS

This research is included in the development research with Plomp model approach. Based on Ploomp's development cycle, Ploomp divides the development stage into three, namely the preliminary research phase, the development or prototyping phase, and the assessment phase. Students in grade VIII of SMPN 2 Kuningan in the 2022/2023 academic year are the subjects of this study.

1. Preliminary Research Stage

In the preliminary research stage, there are four analysis activities carried out, namely analyzing needs, analyzing curriculum, analyzing concepts, and analyzing learner characteristics. Making observations, giving questionnaires, conducting interviews with educators, and interviews with students are ways to collect data at this stage. The research instruments used are checklists, interview guidelines, and questionnaires of learner characteristics. The purpose of this activity is to obtain information about the things needed in the development of learning devices.

2. Development/Prototyping Phase

At this stage, the design of learning devices based on the CPS model is carried out in the form of lesson plans and worksheets. The design of learning device development refers to the results of the analysis in the previous stage. The results of the learning device design are named prototype 1. The next step is to conduct a formative evaluation of prototype 1 with the aim of assessing the quality of the learning tools developed. According to Tressmer, there are several stages in formative evaluation (Plomp & Nieveen, 2013), namely:

1) Self Evaluation

This activity was carried out by researchers and peers. This activity aims to re-check the errors that may still exist in the developed learning tools. The self-evaluation sheet is the instrument needed to carry out this activity.

2) Expert Review

This activity was carried out by experts, namely three mathematics experts, consisting of two mathematics education lecturers and one teacher. After being validated and revised, the learning tool is called prototype 2. The learning device validation instrument by experts is a research instrument used in this activity. Furthermore, the validation results from each expert are presented in the form of a table. Then calculate the average score per item from each expert using formula (1):

$$R = \frac{\sum_{j=1}^{m} \bar{x}_j}{m} \qquad (1)$$

R is the validity of the learning device, $\bar{x}_j$ is the average result of the assessment of the validity of the-j item and m is the total item. The criteria for calculating the validity of learning devices are presented in Table 1. The learning device is said to be valid if the average validity calculation results are more than 2.8.

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Table 1. Validity Criteria

Average	Interpretation
$R > 3.40$	Very valid
$2.80 < R \leq 3.40$	Valid
$2.20 < R \leq 2.80$	Valid enough
$1.60 < R \leq 2.20$	Less valid
$1.00 < R \leq 1.60$	Invalid

Source: (Sugiyono, 2017)

3) One to One Evaluation

This evaluation was carried out by distributing the LKS to three learners with high, medium and low abilities. The purpose was to ask for suggestions from students and ask students to provide an assessment of the worksheets distributed. The interview guide is an instrument used in this activity. Furthermore, the learning device that has been revised after the implementation of one-on-one evaluation is called prototype 3.

4) Small Group Evaluation

This evaluation is carried out by applying learning devices in the form of lesson plans and LKPD to a small group of students consisting of 6 people, provided that the students in the small group evaluation are different from the students in the one-on-one evaluation. The research instruments needed are the learning implementation observation sheet, interview guidelines, and student response practicality questionnaire. The results of the improvement of learning devices after conducting small group evaluation activities are called prototype 4. Furthermore, this learning tool will be tested in large groups (field test).

3. Assesement Phase

At this stage, implement the developed learning tools into the learning process in a large group (field test). In this activity, the researcher is only an observer. To collect data, in this activity an instrument is needed in the form of an observation sheet for the implementation of the lesson plan (RPP), practicality questionnaire for students' responses, practicality questionnaire for educators' responses, interview guidelines, and test questions for mathematical adaptive reasoning skills. After the teacher finishes teaching each meeting about statistics material using the learning tools that have been developed, students are given a mathematical adaptive reasoning ability test. Then the researchers conducted a practicality test and effectiveness test based on the data obtained during the field test.

The data obtained from the practicality questionnaire of students and teachers were used to conduct a practicality test of the learning device. The data was analyzed using formula (2):

$$P = \frac{R}{SM} \times 100\% \qquad (2)$$

where P is the practicality value, R is the number of scores obtained, and SM is the maximum score. After obtaining the results of the calculation of the practicality of the learning device, then the calculation results are grouped according to the categories in Table 2. The developed learning tools are said to be practical if the calculation results of the practicality value are more than 70%. The learning device is said to be practical, if the calculation of P is between $75 \leq P \leq 85$.

Table 2. Practicality Criteria

Practicality Score (%)	Interpretation
$85 \leq P \leq 100$	Very practical
$75 \leq P \leq 85$	Practical
$60 \leq P \leq 75$	Practical enough
$55 \leq P \leq 60$	Less practical
$0 \leq P \leq 54$	Not practical

Source: (Sugiyono, 2017)

The data obtained from the test of students' mathematical adaptive reasoning ability is used to conduct an effectiveness

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test. The test score can be calculated using formula (3):

$$N = \frac{S}{I} \times 100\% \qquad (3)$$

where N is the students' score, S is the number of students' scores, and I is the ideal score. The next step is to determine the effectiveness of the learning device with formula (4):

$$E = \frac{Total\ completed}{Total} \times 100\% \qquad (4)$$

The criteria for device effectiveness can be seen in Table 3. Learning devices are said to be effective if the results of the calculation of the effectiveness value of more than 65%.

Table 3. Effectiveness Criteria

Effectiveness Value (%)	Criteria
$80 \leq x < 100$	Very Good
$65 \leq x < 80$	Good
$55 \leq x < 65$	Enough
$40 \leq x < 55$	Less
$0 \leq x < 40$	Very Less

Learning devices are said to be effective, if the results of the calculation of x are between $65 \leq x < 80$ with a good category.

RESULTS AND DISCUSSION

1. Preliminary Research Stage

At the preliminary research stage there were four activities carried out. In the preliminary stage, researchers conducted four analyses consisting of problem analysis, curriculum analysis, student analysis, and subject matter analysis. The first activity is to conduct a preliminary analysis, based on the results of the preliminary analysis obtained information that the participation of students in learning activities is less active, the learning process tends to be teacher centered, the learning tools used in learning activities are general, not related to mathematical adaptive reasoning skills, and the ability of students in mathematical adaptive reasoning is still low.

Based on the results of the preliminary study, the problems found in the field are that students' mathematical adaptive reasoning skills are still low because the teacher in teaching in the classroom still uses the lecture or conventional method, while students only listen to the teacher's explanation and record things that are considered important so that students do not develop their knowledge. This results in students being inactive or passive in learning and the material taught is not understood by students. In addition, teaching materials or learning resources in the learning process only use teaching materials available at the school, namely package books obtained from the government. The lack of learning resources makes students' abilities low in solving contextual problems or real-life problems.

One of the five standards of mathematical competence that students must have is adaptive reasoning ability (Kilpatrick et al., 2001). Therefore, researchers created learning tools that can train students' mathematical adaptive reasoning skills. The learning tools made refer to one particular learning model, namely collaborative problem solving. As stated by Widjajanti (2011), collaborative problem-based strategies are recommended to develop mathematical skills (conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition).

The second activity was to conduct a curriculum analysis. At this stage, it was analyzed the suitability between the Core Competencies and Basic Competencies in the Permendikbud with the KI and KD in the learning tools used, in this activity it was also analyzed the indicators of competency achievement for mathematics material for grade VIII SMP related to statistics material. The results of the

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analysis show that the existing material is well ordered, but there are some revisions to the competency achievement indicators that will be used.

The result of the curriculum analysis is that the curriculum used by the school is the 2013 curriculum. But in reality, the implementation of the 2013 curriculum has not been implemented optimally because the teaching method is still teacher-centered, so students are less actively involved in learning. Therefore, it is necessary to improve student-centered learning in accordance with the objectives of the 2013 curriculum which expects students who are faithful, productive, innovative, creative and active. One of the student-centered learning models is the collaborative problem solving model that can make students active in learning in groups and can develop their knowledge so that students' mathematical adaptive reasoning skills increase.

The third activity is to analyze the subject matter. The selected subject matter is statistics. Statistics has an important role in everyday life which is confirmed by Sangila & Jufri (2018) that statistics is one of the mathematical sciences that helps human life, for example, it is used in trade, education, business, or in making decisions in politics. Therefore, statistical material is closely related to the problems of everyday life. This is also considered with the time of the research carried out so that the material chosen is statistics material.

The fourth activity is to analyze the characteristics of students. Based on the results of the analysis of learner characteristics, some information was obtained. First, the academic ability of learners varies, starting from high, medium, and low abilities. The second information, students who are research subjects are around 14 to 15 years old, meaning that students already have cognitive development at the formal operation stage. The main characteristic of child development at this stage is being able to think abstractly and logically (Ismail, 2019). So it can be said that the VIII grade students of SMPN 2 Kuningan who are the subjects in this study have been able to participate in learning activities using the CPS model.

Further information is that students prefer to ask their friends when they encounter difficulties in understanding the material, meaning that students prefer discussion activities. The latest information is that students like worksheets that provide direction and guidance for solving contextual problems, and worksheets that provide practice questions related to real life problems.

Results of student analysis. based on the researcher's observations, that when the teacher explained the subject matter, there were still students in class VIII, especially class VIII H, who did not pay enough attention to the teacher's explanation and students' motivation when studying was still lacking, making students passive in learning. So based on the problems above, it is necessary to improve the way teachers teach, namely in groups. One model that can be applied is using a collaborative problem solving model which can motivate students to be actively involved in learning in class through social interaction.

2. Development/Prototyping Phase

Furthermore, the second stage is the development stage or the creation of prototypes designed learning devices as a solution to the problems found. Learning devices are made using Microsoft Word 2010. The design of learning devices made is adjusted to the steps of the collaborative problem solving model. Learning tools in the form of lesson plans are prepared based on the 2013 curriculum whose systematic refers to Permendikbud no 22 of 2016 (Permendikbud, 2016). The lesson plan uses

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a collaborative problem solving learning model based on mathematical adaptive reasoning skills made as many as three pieces for three meetings. The results of the analysis from the preliminary research stage became the basis for developing mathematics learning tools based on the Collaborative Problem Solving model. The learning tools developed in this research are lesson plans and worksheets. This learning tool consists of three meetings with the time allocation for one meeting being 2 × 40 minutes. The following describes the constituent components of the CPS-based RPP that was developed.

(1) Identity of the lesson plan (RPP)

The identity of the lesson plan contains information consisting of the name of the compiler, institution, class and semester, subject, subject matter, time allocation, meeting description, and school year.

(2) Core Competencies (KI)

In the lesson plan, there are two KIs that must be achieved by students in classroom learning activities, namely KI 3 about knowledge and KI 4 about skills.

(3) Basic Competency (KD)

In this section KD from statistics material, namely KD 3.10 about analyzing data based on data distribution, mean, median, mode, and data distribution to draw conclusions, make decisions and make predictions, then KD 4.10 about presenting and solving problems related to data distribution, mean, median, mode, and data distribution to draw conclusions, make decisions and make predictions. Then each KD is translated into indicators of competency achievement (IPK).

(4) Learning Objectives

Learning objectives contain targets achieved in competency achievement indicators and refer to the ABCD formula (audience, behavior, condition, and degree). These learning objectives are presented together with the model, approach and learning method used to achieve the learning objectives.

(5) Lesson Materials

The subject matter in the lesson plan based on the CPS model is grouped based on mathematical objects, namely facts, concepts, principles, and procedures.

(6) Media and Learning Resources

Whiteboards and stationery are tools needed in learning using this developed learning tool. Then the materials needed are LKS, and the learning resources needed are Mandatory Mathematics books for Class VIII Junior High School.

(7) Learning Steps

Learning steps are divided into three main activities, namely introductory activities, core activities, and closing activities. Preliminary activities consist of orientation, apperception, motivation and reference. The core activities consist of the description of each syntax of the CPS model. While the closing activity consists of practice questions, conclusion drawing, and reflection. The syntax of the collaborative problem solving learning model consists of four steps, namely presenting problems, forming discussion groups, solving problems in groups, and presenting discussion results.

(8) Assessment

Assessment of student learning outcomes is divided into three, namely assessment of knowledge, attitudes, and skills. Attitude assessment is carried out by observing honesty, discipline, responsibility, cooperation, and proactivity during learning activities. While the knowledge assessment is assessed through exercises and assignments on the LKS, as well as the mathematical adaptive reasoning ability test. Then for skills assessment is assessed through performance, and portfolio work.

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In addition to the lesson plans, the learning tools developed are the LKS. The worksheets are adapted to the collaborative problem solving learning model and mathematical adaptive reasoning ability-based questions. The worksheets were made into three worksheets for three meetings. The systematic preparation of the LKS is adjusted to the guidelines for developing teaching materials from the Ministry of Education and Culture (2008). The worksheets developed by researchers were designed using Microsoft Word 2010. The number of pages of each worksheet consists of 4-5 pages.

After the learning device or prototype I is made, then at the assessment stage the learning device is validated to three validators to determine its validity. After being validated, the learning device was revised according to the suggestions of the validators so as to produce prototype II.

The characteristics of the developed LKS are as follows:

1) Cover

The LKS cover presents the title of the material to be studied, the mathematical abilities to be measured, the 2013 curriculum logo. The appearance of the LKS cover can be seen in Figure 1.

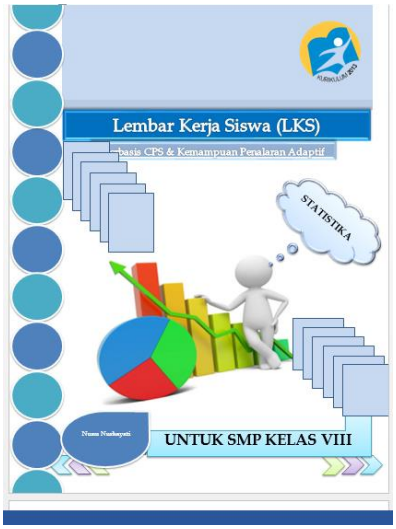

Figure 1. Cover of the worksheet

2) Title Page

The title page contains the title of the material on each LKS, the identity of the learner group, the instructions for use, and the learning objectives to be achieved.

3) Content of the worksheet (LKS)

In the content of the LKS there are stages of learning activities that will be carried out based on the stages of the CPS model. The first activity is the existence of a problem, making plans to solve problems individually, group completion, and transfer of work results. After doing all the activities at each stage of the CPS model in the LKS, followed by working on exercise questions. This CPS-based worksheet is equipped with practice questions on mathematical adaptive reasoning skills, as well as questions related to the application of concepts and formulas that have been learned.

The learning tools in the form of lesson plans and worksheets based on the CPS model developed have gone through the validation stage. The first stage before validation is self evaluation, then based on the results of self evaluation the learning device is revised. Furthermore, it was validated by three experts at the expert review stage. The results of the lesson plan validation can be seen in Table 4.

Table 4. Results of RPP validation

No	Aspects assessed	Average Validity	Criteria
1	Contents	3.46	Very Valid
2	Language	3.57	Very Valid
Average		**3.52**	**Very Valid**

Based on Table 4, the content aspect is on very valid criteria and the language aspect is on very valid criteria. Overall, the developed lesson plans have an average validity score of 3.52 with very valid criteria. This means that all components of the CPS-based lesson plan developed are valid, in accordance with applicable rules, and the

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language used is in accordance with good and correct Indonesian language rules. Furthermore, the results of the LKS validation can be seen in Table 5.

Table 5. The results of the LKS validation

No	Aspects assessed	Average Validity	Criteria
1	Content	3.58	Very Valid
2	Language	3.56	Very Valid
3	Presentation	3.62	Very Valid
4	Graphics	3.42	Very Valid
Average		**3.54**	**Very Valid**

Based on Table 5, all aspects assessed on the validation of the LKS are on very valid criteria. Overall, the CPS-based worksheets developed have an average of 3.54 with very valid criteria. This means that based on the content aspect, the presentation of the content made in the LKS is sufficient to achieve the learning objectives and in accordance with the indicators of mathematical adaptive reasoning, the problems given are in accordance with the cognitive development of students, logical and correct based on the rules. Furthermore, based on the language aspect, it means that the CPS-based LKS developed is in accordance with good Indonesian language rules, the sentences used are communicative and do not lead to different interpretations, the use of terms and symbols is easy to understand. Then based on the dictactic aspect (presentation), the CPS-based LKS has presented learning activities systematically, has facilitated learning in accordance with the learning stages according to the CPS model. Finally, based on the graphical aspect (appearance), the color combination of the LKS is attractive, the image layout is proportional, the type and size of the font is correct.

After validating the experts, the next step is to conduct a one-on-one evaluation and small group evaluation. The results of the LKS practicality test in the small group evaluation were 89.58% with a very practical category, and the results of the learning device effectiveness test in the small group were 76.84% with good criteria. Furthermore, learning devices that have been revised after the implementation of small group evaluation activities will be tested in a class.

3. Assesement Phase

The field test was conducted in one class with the condition that the students in the class were not students in the one-on-one evaluation and small group evaluation stages. The data obtained at this assessment stage is used to determine the practicality of learning devices in large groups, and determine the effectiveness of learning devices. At the field test stage, the practicality results for students' responses to the LKS were 89.66% with very practical criteria, while the practicality results of the teacher's response to the lesson plan and LKS were 91.60% and 94.52% with very practical criteria. This means that CPS-based lesson plans and worksheets can be used by teachers and students easily, logically, and continuously without any significant obstacles.

The effectiveness of CPS-based learning tools is 82.70 with very good criteria. This means that the resulting device has a good impact on improving the mathematical adaptive reasoning skills of class VIII students of SMPN 2 Kuningan. Comparison of the results of the percentage of achievement of mathematical adaptive reasoning ability indicators in pretest and posttest can be seen in Table 6.

Table 6. Comparison of the results of the percentage achievement of mathematical adaptive reasoning ability indicators

Indicator	Aspects	Pretest (%)	Posttest (%)
1	Make conjecture	45.17	80.42
2	Provide reasons	40.56	70.45
3	Draw conclusions	35.73	83.58
4	Check the validity argument	51.36	72.52
5	Find patterns	53.45	81.24
Average		**45.25**	**77.64**

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Based on Table 6, it can be concluded that there is an increase in the percentage of achievement of each indicator of mathematical adaptive reasoning ability from pretest to posttest. In other words, the mathematical adaptive reasoning ability of students has increased after participating in learning with the use of CPS-based learning tools.

This is in line with Rahmat (2019) that one of the learning models that can make students active in learning is collaborative problem solving because this model is a combination of collaborative and problem-based learning which focuses more on student learning activities in groups, helping and guiding students in difficulty and developing their understanding. Similarly, Nelson (1999) states that collaborative problem solving learning allows for a collaborative but not comprehensive learning environment. A learning environment that can support students to collaborate naturally and effectively is very important to create, so that students can develop their knowledge through their own experiences. Based on this need, a collaborative problem solving learning model was created that is supported by students' problem solving activities, where students can make agreements based on each student's natural collaborative process.

In accordance with what was stated by Setiaji (2016) collaborative problem solving is a learning where students have a role to participate in groups to solve problems together. This learning involves other group members in the learning process so that it requires cognitive and social skills to convey understanding, knowledge, exchange information, create and understand each other's groups, and take coordinated action to solve problems.

As said by Herman (2007), giving problems to students individually is quite effective because each student gets ideas on how to find solutions to the problems given. Then during group discussions with the provision of different ideas from each group member, students can construct their knowledge through new information obtained during discussions that have the potential to improve students' reasoning skills.

This learning tool has been validated by several mathematics education experts. The validation results show that this learning tool meets the criteria of very valid, although there are some parts that need to be improved. The things that need to be improved are related to the questions that guide in finding mathematical concepts designed to be described more structured and directed. After that, revisions were made to re-examine the questions that lead to finding the concepts designed during the learning process. Furthermore, validation of learning devices focuses on improving students' mathematical adaptive reasoning skills. The validation instrument adjusts 5 indicators of adaptive reasoning ability, namely making conjectures, providing reasons or evidence for the truth of a statement, drawing conclusions from a statement, checking the validity of an argument, finding patterns in a mathematical phenomenon.

Based on the results of the validation of Collaborative Problem Solving-based mathematics devices declared valid by validators through several aspects observed, namely presentation or didactic aspects, content feasibility aspects, linguistic aspects and graphic aspects. So, this learning tool has met the validity criteria and is suitable for use, then it is tested in the next research stage. This is in line with the results of research by Yelianti (2020); Siregar, Rosli, & Maat (2020); Liljedahl (2005) that the product design developed meets the valid criteria and is suitable for use in the next stage.

This research has a positive impact on students' interest in learning mathematics, there is an increase in students' interest in

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learning, this can be seen from the activeness of students when discussing during the learning procession. Another impact is the emergence of students' learning independence in solving problems through guidance and guidance in the LKS in the form of questions that guide students to solve the problems given. The learning tools developed are valid, practical, and effective in improving mathematical adaptive reasoning skills. This research is in line with Kurniati (2013) that one of the criteria that can determine whether or not the device developed is the result of expert validation, with the assessment of the experts used to revise the learning device.

The development of learning tools through a collaborative problem solving model based on mathematical adaptive reasoning skills refers to the Plomp development model which consists of three stages, namely the preliminary stage, the development or prototyping stage, and the assessment stage. Learning tools developed in the form of lesson plans and worksheets on statistical material. The advantage of the developed LKS is that it has a pictorial appearance or design that attracts students' attention. In addition, the stages on the LKS are in accordance with the collaborative problem solving model based on adaptive reasoning questions that can develop and improve students' mathematical abilities.

In this study, researchers developed LKS as teaching materials that can help students understand the material, make students active in the learning process, and can train students' mathematical adaptive reasoning skills. This research is in line with Prastowo (Putri, 2016) states that the function of student worksheets is as teaching materials that can minimize the role of teachers in learning (student centered) and make students more active in learning, as teaching materials that can make it easier for students to understand the subject matter. This research can contribute to the world of education, especially for teachers, providing an overview of knowledge in developing varied LKS using the CPS learning model that can develop students' adaptive reasoning skills.

This research on the development of learning tools based on the CPS model has limitations, namely learning tools based on the CPS model in the form of lesson plans and worksheets can only be used by students in grade VIII SMP. The worksheets developed are limited only to the subject matter of statistics. The worksheet is simple and designed using Microsoft Word 2010 application. The worksheets developed are printed using ordinary printing machines so that the quality of the images, letters and colors produced is not optimal. The weaknesses of this study are that the learning devices were only validated by three validators, so the suggestions and input to improve the learning devices developed were limited.

CONCLUSIONS AND SUGGESTIONS

Referring to the research objectives and the results of the data analysis obtained, it can be concluded that the mathematics learning tools in the form of lesson plans and worksheets based on Collaborative Problem Solving produced are in accordance with the criteria of valid, practical, and effective to improve the mathematical adaptive reasoning skills of class VIII junior high school students.

The mathematics learning tools in the form of lesson plans and student worksheets (LKS) based on Collaborative Problem Solving developed have been proven valid and practical. This is reflected in the evaluation of the aspects of presentation or didactics, material content, language, and visual appearance.

The practicality of this learning tool can be seen from its ability to be used in accordance with the design that has been prepared, which is reflected in the readability

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and clarity of the material, ease of use, attractiveness, and appropriate time allocation. In addition, this learning tool has proven effective in improving students' mathematical adaptive reasoning skills. This can be seen from the average test score for the five indicators of adaptive reasoning which reached 77.64% in the good category.

For other researchers, to test the learning tools that have been designed in other schools to evaluate their effectiveness in different learning environments. This can provide a broader insight into the success and generalization of these learning tools. For school principals, it is recommended to improve the quality of learning by strengthening teacher competence through training that integrates the Collaborative Problem Solving model. This will help teachers in developing innovative and effective learning strategies.

For teachers, it is recommended to develop learning tools that suit the characteristics of their learners. By paying attention to individual needs and learning styles, teachers can increase the effectiveness of mathematics teaching and help learners achieve better mathematical skills.

Based on the results that have been concluded from the results of this study, the authors have several suggestions regarding the learning devices developed, including: (1) The learning tools developed would be better if the learning tools developed are in other forms such as modules or textbooks designed using other applications such as Corel Draw for other mathematics subjects; (2) The learning tools developed would be better validated to more than three validators, so that they can get more suggestions and input to improve the learning tools developed and to make it more interesting for students to learn mathematics.

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