The study of the mathematical problem solving and metacognition strategy on a paired Handep cooperative learning model

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Abstract. Mathematics problem-solving skill is essential in mathematics learning. However, the difficulty to solve mathematics problem still occur. The model of learning created based on cooperation culture of Dayak tribe developed to facilitate the learning. The research aimed to create the draft of Handep cooperative learning model as single path prototype level, to evaluate the feasibility of model components and to assess the problem-solving and metacognition questioning strategy fulfillment, to obtain the model of mathematical problem solving and metacognition strategy based on the local wisdom. Research and development used were the Recursive, Reflective, Design, and Development-Dissemination (R2D2). The development focused on Handep cooperative learning model construction. The learning technology expert reviewed the feasibility of the model, and the mathematics-learning expert validated the fulfillment of problem-solving and metacognition questioning strategy. Instruments were included questionnaire and rubrics. The result of the paired Handep cooperative learning model and experts’ validation result concluded that learning technology experts agreed that the components of the model are feasible as a model of cooperative learning. The mathematics-learning experts found that the model has feasibility for mathematical problem-solving strategies. For advanced expert validation, it is recommended to assess the fulfillment of critical elements of the Handep cooperative learning model.

1. Introduction
Mathematics problem-solving skill in K-13 is a competency to develop students' mathematics ability [1]. The mathematics problem-solving skill is essential to develop students’ ability [2]. The mastery of mathematics problem-solving skill is a cornerstone, which facilitated the improvement of reasoning and critical thinking.

The objective for mathematics problem-solving skill is a challenge for teachers and students in Indonesia. Difficulties in solving the mathematics problems in schools still occur. Results of research on mathematical problem solving explained that students still solve mathematics problems [3]. Students have the challenge to remember facts and concepts, understand issues, understand ideas and use them, as well as difficulty communicating meta-cognition in solving math problems [4]. Mathematical difficulties found in formulating equations, schemes, diagrams to create mathematical models of algebra materials in junior high school [5]. One of the contributing factors is the lack of effort to make innovations in learning and still using rigid learning models that sometimes are outside
of the Indonesian learning context. Therefore, this research will study the feasibility of the local wisdom as an idea for developing a cooperative learning model.

The innovation of learning method has done in Indonesia but it is still limited to some areas. Indeed, Indonesia has diverse ethnicities, various local wisdom; which teachers potentially used as a basis for innovation in education. Cultural factors are believed to affect the thinking process of understanding mathematical concepts [6,7]. Mathematics is the result of the cultural or human thought that is dominated by the western world [8,9]. When students from other cultural contexts learn math, students experience the conflict of thinking. Students construct mathematical knowledge when they overcome the friction; where learners have been able to accept, modify understanding in the context of thinking. The cultural background of students influences this process. Mathematics as a result of culture will experience enculturation in diverse contexts of various cultural backgrounds of students.

The pattern of cooperation in Dayak, Central Kalimantan is a form of local or indigenous knowledge. It is known as Handep. Handep cooperation has inspired the creation of cooperative learning model [10]. Handep is a word in Dayak, which means ‘help each other.’ The uniqueness of cooperation with Handep is the mutual collaboration between community members who agree to cooperate, by mutual give Handep (assistance) to other members and receives andep (who receive support) from other members in turn. The benefit of the andep is to enhance the ability of each community member [11,12].

The implementation of Handep learning model with group member 3-4 people for learning mathematics at SMPN-1 Palangka Raya conducted by Demitra and Wulandari [13] showed mastery of cube and block concept on students taught by the Handep model were higher than Student Team Achievement Division (STAD) model. However, in the aspect of motivation, there is no difference. The results of the classroom observation showed that the students had difficulties in carrying out group cooperation, in which the number of group members was 3-4 students. After reflecting on the encountered challenges and addressing the faced problems in front of friends in the group, the more talented students or smarter student did not want to help their friends who had difficulty solving math problems. The process of collaboration in the group is less smoothly. One of the causative factors observed was the number of 3-4 group members making the students reluctant to assist friends in groups. Cooperation with the number of group members of 3-4 people seems less suitable for students in junior high school. The researcher solved this problem by elaborating on the development of the Handep model, to reduce the group member to two or a paired group.

The purpose of this research is to explore the Handep model of a paired group and to evaluate the feasibility of component model and validation of fulfillment of mathematical problem solving and metacognition question strategy. The research problem was, firstly, how is the structure of the paired Handep model in single path prototype? Second, how is the feasibility of the cooperative learning paired Handep model as a proven model of learning to found the model in the alpha version?

2. Method
The research is development research the development model of Recursive, Reflective, Design, and Development-Dissemination (R2D2) according to Willis [14]. The study used the descriptive method in ways of qualitative and quantitative approach. The activity on define focus involves creating and supporting a participatory team. It is a core team building activity consisting of two people (research team) and then involving experts as supporting groups during the development process. So the subject is supporting group, that they are experts in the field of learning technology there are two people and experts in the area of mathematics learning there are two people.

Progressive problem-solving activities in the design of cooperative paired cooperative learning model, beginning with formulating problems of learning mathematics and defining goals, and seek solutions to these problems. The researcher examines the components of the model that are suitable for constructing the learning model. Development activities prognosis or learning context is done by studying the context of learning mathematics in junior high school. The researcher explores the
cultural context of the Dayak ethnic of Central Kalimantan. The reference syntax of the paired cooperative learning model related to this culture.

The focus of design and development involves creating Handep cooperative learning model. The researcher has done the process of designing cooperative paired learning in the early stages of the activity, by creating the model through the synthesis process toward the components of mathematical problem-solving procedures [15,16], metacognition thinking strategy [17,18,19] and the syntax of Handep model [10], and Handep cooperative procedures originating in of Dayak culture [11]. The researcher conducted the model development process by building and elaborating Handep model to get various types of the cooperative paired learning model. From the previous research, the Handep model procedure covers four steps, i.e.:

- Presenting the new material. Teachers recall material prerequisites and present new material to students. Then ask students to relearn by working on the worksheet.
- Troubleshooting individually. Students learn the material in the worksheet and work on solving problems in the questions contained in the worksheets facilitated by metacognition questions. Four stages of mathematical problem solving included understanding the problem, planning the solution, executing the problem-solving plan, and re-checking the solution.
- Solve problems using Handep. Students form groups in pairs and sit in opposite positions to make face-to-face interactions and convey the difficulty to solve problems with their partners in turn. Couples agree on a turn to solve the problem, and one student helps his/her partner in solving the problem-solving. The partner who has received help, assist other friends in solving the problem. All members did this stage until all the members can solve the problem.
- Present the results of solutions and celebrate success. Students post a problem-solving sheet on the wall or the board. Alternatively, present the results of split-ups on the board and explain if anyone asks from other groups. Each group presents their solutions. The teacher assesses the student's work. After completing the problem-solving results, students sing a song or yell for their success.

Stages of model elaboration, as follows (1) development of a detailed and descriptive learning model draft [20]; (2) expert test; (3) field test (small group); and (4) field test (in one class at school). The development of this learning model uses the R2D2 development model [14]. Expert validation is used to get the alpha version. The alpha version is the model development result after validated by experts. Expert validated the model by requesting a learning technology expert to assess the feasibility of the component of the paired cooperative learning model. Expert validation was also sought from mathematics problem-solving learning experts to assess the fulfillment of problem-solving strategies and meta-cognition questioning strategy [17,18,19]. The reference to revising the model based on the result of the assessment of mathematics learning and learning technology expert. The data are narratives opinion and percentage fulfillment of mathematical problem-solving component and metacognition question strategy. The data analyzed through meaning the expert opinion and constructing presented tabulation of the result of the expert assessment of the model.

3. Result and discussion

3.1. Single path prototype level
The product result of the prototype of the Handep model is the textbook. The first step in developing the prototype was the basic theory construction as the basis of the learning model. This model is based on teaching and learning theories in the view of constructivism, especially on mathematics. The next basis is the theory of cooperative elements, useful learning principles, and quantum learning approach. Teaching and learning mathematics contains problem-solving strategies and meta-cognition questioning strategies. The book title is Model Pembelajaran Kooperatif Handep Berpasangan [Paired Handep Cooperative Learning Model]. The prototype of the draft model is already at the single path prototype level.
3.2. Expert validation for the alpha version
The draft of the model at the level of single path prototype needs to be refined to get the excellent model. At this level, the draft model would be validated by two people who the learning technology expert (who will review on the constructivism theories) and two people whom mathematics was learning expert (review on the mathematics problem-solving strategies). Table 1 shows the result of the review of learning technology experts.

Table 1. The result from learning technology expert

| Question items                                                                 | Review result                                                                                       |
|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| **A. Syntax**                                                                 |                                                                                                   |
| 1. Does the primary step of learning refer to the paired HAndep mechanism?     | Yes. The learning step referred to the paired HAndep mechanism                                      |
|                                                                                | Already                                                                                           |
| 2. Is the learning step relevant to the cooperative/collaborative learning    | As a prescriptive, the steps already have cooperative/collaborative learning                      |
| characteristics?                                                              | Almost all the steps are relevant to the primary procedure of collaborative activities.          |
| 3. Based on the learner characteristics at what education level this model     | Probably at all levels, but it requires some modification at some level.                           |
| syntax will be fit or suitable?                                                | This model will be suitable for student upper of junior high school.                              |
| 4. Is the learning step refer to the HAndep cooperative components, mathematics problem solving, and metacognition questioning? | Already                                                                                           |
|                                                                                | Already                                                                                           |
| 5. At what part of this syntax should be improved or revised?                  | Nothing to be revised                                                                             | The syntax parts are already detailed                                                             |
| **B. Instructional effect and nurturing effect**                               |                                                                                                   |
| 1. That is the possibility to achieve the learning goals if this model is applied? | This model can be used to achieve the learning goals                                               | The learning goals can be met because the procedure of this model is student oriented.          |
| 2. If this model is applied, what social skill would the students acquire?    | Patient, appreciate other, self-esteem, communication skill, reduce ego                           | Collaboration skill on problem-solving, not judgment someone                                      |
| **C. Overall components**                                                     |                                                                                                   |
| 1. Does the prescription on the components give the complete explanation of the model? | The prescription is comprehensive and self-explanation                                            | The components are detailed enough to describe the overall expected model                        |
3.3. Assessment by mathematics learning experts

The results of the mathematics-learning expert on mathematical problem solving and meta-cognition questioning strategies are figure out in Table 2. Both experts assessed that paired Handep cooperative learning models had met the problem-solving stage to understand the problem and implement problem-solving (87.5%). In both aspects, it still needs to be added explanations on how to math problems and solve problems.

While aspects of planning problem solving and re-examining, paired Handep cooperative learning model have fulfilled (100%). Similarly, in the element of giving metacognition questioning strategy has achieved 100%. Fulfilling aspects of mathematical problem-solving strategy is 90.63%. This result means that cooperative paired cooperative learning model has fulfilled the stages of solving mathematical [15]. There are four stages: understanding the problem, making the plan of solving, executing the plan of solving, and re-checking the result. With the component of mathematical problem-solving strategy in paired Handep cooperative learning model able to facilitate the process of reasoning, mastery of problem-solving skills of mathematics to students. Results of the previous research indicate that the mathematical problem-solving strategy [15] can develop mathematical proficiency [16,21,22]. However, it still needs a prescriptive explanation on the stages of creating a plan for solving and examining the results.

Table 2. The result from mathematics learning experts

| Aspects                  | Maximum Score | Item Score | Expert 1 | Expert 2 |
|--------------------------|---------------|------------|----------|----------|
|                          |               |            | Freq.    | %        | Freq.    | %        |
| A. Mathematics problem solving |               |            |          |          |          |          |
| 1. Understand the problem | 12            | 3          | 2        | 50       | 2        | 50       |
|                          |               | 4          | 1        | 33.3     | 1        | 33.3     |
|                          |               | Sum        | 10       | 87.5     | 14       | 87.5     |
| 2. Plan to solve the problem | 8             | 4          | 2        | 100      | 2        | 100      |
|                          |               | Sum        | 8        | 100      | 8        | 100      |
|                          |               | 3          | 2        | 37.5     | 2        | 37.5     |
| 3. Execute the problem solving | 16            | 4          | 2        | 50       | 2        | 50       |
|                          |               | Sum        | 14       | 87.5     | 14       | 87.5     |
|                          |               | 3          | 2        | 75       | 0        | 0        |
| 4. Re-check the solution | 8             | 4          | 0        | 0        | 2        | 100      |
|                          |               | Sum        | 6        | 75       | 8        | 100      |
| Average                  |               |            |          | 87.5     |          | 93.75    |
| Average of both experts  |               |            |          |          |          | 90.63    |

B. Metacognition Questioning

| Aspects                  | Maximum Score | Item Score | Expert 1 |
|--------------------------|---------------|------------|----------|
|                          |               |            | Freq.    |
|                          | 12            | 4          | 3        |
|                          |               | Sum        | 12       |

The results of the assessment on the meta-cognition questioning strategies aspect were 100%. It means that this model has fulfilled all aspects of the strategy. The fulfillment of this meta-cognition
questioning strategy aspect provides an excellent opportunity for this model to facilitate the students' mathematical reasoning process. Previous research [7,18,19] showed that the use of meta-cognition questioning strategies in mathematics learning could improve the learning outcomes of mathematics. The results of the expert's validation indicate that the Handep cooperative learning model has been eligible to be declared a model of learning.

The validation results of the feasibility of model components and the fulfillment of mathematics problem-solving strategy and meta-cognition questioning strategy in the Handep cooperative learning model become the reference for revising the model. To revise the model, the researcher needs to assess from aspects of the fulfillment of elements of the cooperative learning model [23], the leading principles of active learning and the principles of quantum teaching [24].

4. Conclusion
Based on the results of elaboration of paired Handep cooperative learning model and expert validation result, it is concluded that learning technology experts agreed that the components of the model are feasible as a model of cooperative learning. The mathematics-learning experts find that the model has components feasibility for mathematical problem-solving strategies. For advanced research, it is recommended to assess the fulfillment of critical elements of the Handep cooperative learning model in the real implementation in the classroom.

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