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## The use of collaborative learning method with reciprocal technique in physics class problem-solving at a high school

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**ABSTRACT:** The aim of this study is to find an effective learning method for a physics class, by comparing the collaborative method with the reciprocal technique, and the discussion technique. For upper middle school students, the physics class is one of the more difficult lessons. It is hoped that using the right method can have a positive effect on student learning outcomes. This type of investigation is an actual experiment. The post-test only control group was used as part of research design methodology. The population is senior high school students at the same level in nine Gowa districts, Indonesia. The sample of 118 students was divided into two class groups. SPSS software was used to analyse the data. The students taught via the collaborative method with the reciprocal technique of experimental class got higher scores than the control class student score with the discussion technique. A conducive atmosphere needs to be created, so that in learning, the students no longer feel anxious, no longer feel afraid of participating, no longer perceive it as an obligation, but become conscientious and willing to learn in a comfortable and pleasant atmosphere.

### 2 INTRODUCTION

The way people learn and deal with problems, largely depends upon the link between personality and cognition. This link is called the cognitive style. Cognitive styles can be described as the manner in which information is acquired and processed by the brain. There are many cognitive styles, such as spatial visualisation, sequential or parallel processing; hemispheric lateralisation (left versus right brain) also plays a role [1]. At the formal academic level, mutual learning becomes one of the options given the increasing population of learners with diverse capabilities and the broader paradigm of education that emphasises the active participation of students, such as learning in pairs (peer learning).

The learning process of cognitive strategy is a process of reflection in action. As one component of teaching and learning activities, teachers have a particular position on the success of learning, because the primary function of teachers is to design, manage and evaluate learning [2].

The Indonesian educational system is also part of this chain and, it too, must adjust and adapt to these new changes to meet the needs of the globalised world by moving towards global education or, in this case, a comprehensive curriculum [3]. Collaborative learning illustrates various educational practices through which interaction among peers is the most important factor in learning, although other factors, such as instructional materials and interaction with teachers are important [4].

Problem-based learning (PBL) is used in learning to engage learners, and support students in activities that develop them into professional practitioners [5]. Problem-based learning integrates learning in science and problem-solving skills, takes advantage of collaborative situations, and emphasises the process of *learning to learn* by giving students maximum responsibility for determining the learning process.

The choice of teaching content should take into account the nature of each student. Content must also address the learning ability and level of student understanding. In the process of teaching and learning, to attract the attention and enthusiasm of students, teachers must use excellent teaching aids. Innovation requires a psychological orientation for active exploration and discovery. If students feel empowered, then, they will participate in the learning process. Only by giving full encouragement and arousing enthusiasm will students then dare to think and talk freely and reach their highest potential [6].

The physics lesson is one of the harder lessons for learners, especially in upper middle schools in Gowa districts. It causes students to be passive in the process of learning in the classroom. The result is that, the material obtained does not last long in the minds of students, because they only receive material from the teacher without the reciprocity of

being active. Based on the above, it is expected that collaborative methods with reciprocal techniques could produce a positive effect on the learning outcomes of students.

#### THEORETICAL FRAMEWORK

Education is a dynamic force in the life of all individuals, affecting their physical, mental, emotional, social, and ethical development [7]. Education not only equips learners to master science and technology, and allows them to develop the ability to work and solve problems, but also provides the capacity to live with other people with a different tolerance, understanding and without prejudice [8][9]. Education should be directed to the formation of learners who realise that they are living in a global world with many people from different languages and ethnic, religious and cultural backgrounds.

Collaborating means working with others. In practice, collaborative learning means learners work in pairs or in small groups to achieve shared learning objectives. Collaborative methods involve learning through group work, not working alone. The first aspect of collaborative methods is deliberate design. Teachers ask learners to form groups and then work. In collaborative ways, teachers plan the design of learning activities for students. They can do this by choosing unstructured activities. Another aspect of collaborative methods is the important process of learning. When students work on a task in a cooperative manner, they must also gain knowledge or understand the curriculum of the subject. Although for most educators, let alone the compilers of lexicography, the terms collaborative and cooperative have almost the same meaning, but when applied to group learning, these two words will trigger debate and discussion regarding the sense of both [10]. Simply put, cooperative methods can be defined as *...the formation of organised small groups*.

Table 1: Procedures of collaborative methods with reciprocal techniques.

No	Collaborative methods	Reciprocal technique
1	Submission of goals and motivation of students.	The teacher asks the students to determine their learning objectives at the meeting from the reading material they have learned from.
2	Presentation of information in the form of demonstrations or through reading material.	The teacher asks the learners to make a list of questions and answers that relate to key points derived from reading the material or other learning tasks. Students read the material provided by the teacher, then make a list of questions and answers related to the main points derived from reading the material or other learning tasks. (It is better if reading material is given to the students in the classroom, so that they can learn from the material at home).
3	Organising learners in learning groups.	Establish groups or pairs, or ask learners to pair up with the student sitting next to them. Students form a pair with the student sitting next to them.
4	Guiding learners.	Explain the process by which the pairs give each other questions and answer their partner's questions. Listen to the teacher's explanation. Student A starts asking the first question and student B answers the question. Student A offers additional corrections and information until satisfactory answers are achieved. Student B asks the next question and student A answers it; the process is repeated until all the issues have been requested and answered.
5	Observing the students' questions.	The teacher checks the learners' worksheets.

Some theorists agree that the difference between cooperative methods and collaborative methods is only at the level of structure used by both [9], but others see that the difference between the two types of learning is also concerned with more general issues [10]. However, the latter difference is not widely accepted and still leaves controversy. According to Bruffee, cooperative methods are more appropriately applied to elementary school learners, while collaborative methods are more suitable for adults, including university or college students [11].

It is assumed that the primary-level students still do not have adequate social skills to cooperate effectively. Meanwhile, in collaborative methods, it is assumed that the students already have the social skills and motivation needed to achieve shared learning objectives. Moreover, in collaborative methods, learners are responsible for organising and self-evaluating their groups. The activities of collaborative methods involve the acculturation process by lecturers and students. Because collaborative methods enable students to make their own decisions, while in traditional teaching, this authority is usually owned by teachers. In fact, advocates of collaborative methods suggest a more democratic process, giving students more power, unlike in traditional teaching in general [12].

## RESEARCH METHODS

This type of investigation is a true (actual) experiment. The post-test only control group was used as part of research design methodology. This model involves at least two groups, both of which are formed by random placement. The two groups were administered the test on the non-free variable; one group received the new treatment, and the two teams were given a post-test. Post-test values were then compared to determine the effectiveness of the treatment [13].

The research population was drawn from all nine high schools in Gowa Regency of South Sulawesi Province in the school year 2015/2016, with a total sample of 118 people. Classroom random sampling consisting of one control class and one experimental class was undertaken, assuming that the whole class was homogeneous.

In the experimental class, learners were initially unfamiliar with the methods and techniques provided. Initially, students did not understand the purpose of learning, but at the next meeting, they became interested in the learning process. Then, in the control class, students were given reading materials and tasks to be done in groups. Because of passive learners in learning activities, the teacher provided an explanation of the reading materials, so that the learners could do the task well. Applied discussion techniques required cooperation among students in completing the task. After that, the students completed the task with their group.

Inferential statistical analysis was used in the research to test the research hypothesis by using a *t*-test, previously tested the basics of analysis using normality test and homogeneity test. The statistic package for social scientists (SPSS) was used for analysing the data [14][15].

## RESULTS AND DISCUSSION

A normality test was performed on the score for each group with the aim of knowing whether the population data was normally distributed or not. All calculations were done using SPSS program.

Testing the normality of learning result score in the experimental class, from the calculation result is  $x^2_{count} = 5.80$ , while the value of  $x^2_{table}$  in the real level is  $\alpha = 0.05$  obtained  $x^2_{(0.95)(4)} = 9.49$ . Based on the results and test criteria, it can be seen that  $x^2_{count} < x^2_{table}$ ; thus, the data of the scores of creative thinking skills in the experimental group participants came from a population that is normally distributed at a significant level  $\alpha = 0.05$ . For the normality test score of learning outcomes in the control class, the calculation results obtained  $x^2_{count} = 7.04$ , while the value of  $x^2_{table}$  in the real level was  $\alpha = 0.05$  and purchased  $x^2_{(0.95)(3)} = 7.81$ . Based on the results and test criteria, it can be seen that  $x^2_{hitung} < x^2_{tabel}$ ; thus, the scores of creative thinking skills in the control group participants were derived from the normally distributed population at a significant level  $\alpha = 0.05$ .

Data homogeneity test obtained  $F_{count} = 1.44$ , while for the real level  $\alpha = 0.05$ , obtained  $F_{(0.05;39-1; 39-1)} = F_{(0.05; 38;38)} = 1.72$ . Therefore,  $F_{count} = 1.50 < F_{table} = 1.72$ , it shows that the data of learning result scores achieved by the experimental class and control class have homogeneous variance at a significant level  $\alpha = 0.05$ .

### Hypothesis

The results of data analysis obtained  $t_{count} = 3.24$ . The  $t_{table}$  value with  $\alpha = 0.05$  was 1.99. Based on the test criteria, then,  $t_{count} > t_{table}$ . Thus, it can be concluded that there are significant differences in the learning outcomes of students of the middle school physics class of Gowa districts taught by collaborative methods with reciprocal techniques, and those taught by the method of discussion. The description of learning outcomes of learners between two classes; namely, the experimental class taught by using collaborative methods with reciprocal techniques and the control classes taught by discussion techniques is shown in Figure 1.

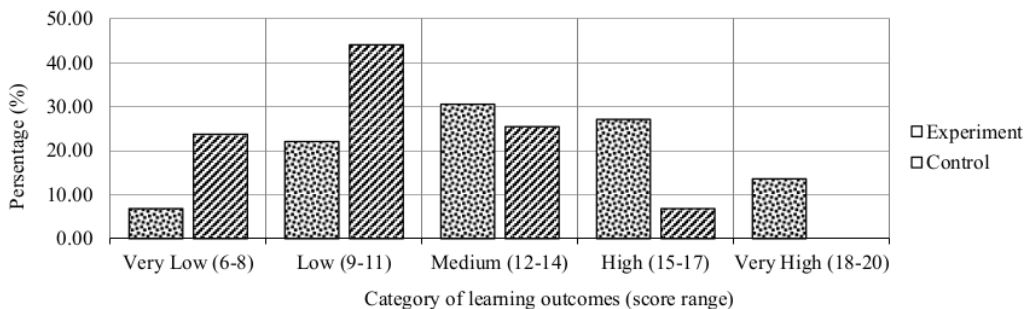


Figure 1: Experimental classroom learning results and control classes.

Figure 1 shows the comparison between the experimental class and control class learning outcomes from very low to very high categories with the lowest score interval 6 to the highest 20. Categories were very low (6 to 8) for the

experimental class of 6.78% and 23.73% of the control class; low (9 to 11) for the experimental class of 22.03% and 44.07% for the control class; medium (12 to 14) for 30.51% for the experimental class and 25.42% for the control class; high (15 to 17) amounted to 27.12% of the experimental class and 6.78% of the control class. Figures for very high (18 to 20) for the experimental class and control class were 13.56% and 0.00%, respectively.

The results of the statistical analysis reveal that the scores of middle school physics class students in Gowa districts given by the collaborative methods with reciprocal techniques in the experiment class were different from those students learning in the control group. It can be seen in Figure 1 that there is a tendency for better student learning outcomes of students taught with a method based on collaborative methods with reciprocal techniques.

The inferential statistical analysis was performed to prove the proposed hypothesis and to support the descriptive analysis results described. Thus, the result of the analysis using a *t*-test, significantly confirms that there are differences in physics learning outcomes of students in middle school science classes in the Gowa Regency when taught using the collaborative methods with reciprocal techniques compared with those being taught using the discussion technique.

The results that have been described show that students who are taught by collaborative methods with reciprocal techniques in the experimental class obtained a higher score compared with the student rating in the control class with discussion techniques. The applied reciprocal techniques made students more active and more adaptable to new materials, especially in physics classes, which is one of the classes considered to be more difficult by most students.

Social science teachers liken teaching to conducting orchestras, choosing and incorporating teaching strategies and teaching resources to help their students learn. They emphasise different strategies in varying the times spent on learning activities. Because each strategy has its advantages and disadvantages, effective teachers can choose the activities their students can enjoy or are needed by their students to practice and learn. But, this does not mean that teachers should use the strategies most preferred by their students, but teachers can also develop their creativity as long as they can professionally provide the reasons for their choices and combine their choices.

Collaborative methods should create a conducive social environment for the implementation of interactions that combine students' willingness and learning abilities. The environment was created in the form of small groups. Thus, learners can define the roles of their team members. But, to be more efficient, collaborative groups were divided based on the seating position. So, each student could arrange a sitting with a friend in the class. It can also facilitate group interaction [16]. Learners can develop analytical and synthesis skills and be able to formulate new values taken from their analysis. More efficient learning involves students in accessing various information and knowledge to be discussed and studied in the learning process in the classroom, so that they gain experience that can improve their competence [17].

During the study, the researchers discovered the advantages and disadvantages of reciprocal techniques applied in high schools in Gowa districts. The benefits of those methods are as follows:

- 1) Each learner contributes actively in the group, because a group consists of only two students;
- 2) The social relations of students in the group can help understand the learners, because they are already familiar with the social environment where it is easier for learners to transfer each other's knowledge;
- 3) Students are required to create their questions, so that they are indirectly encouraged to understand the subject matter more, so that the issues they raise are more and more weighted;
- 4) Learners are given material to read at home, so that at the time of class learning, students already understand the material to be studied.

Also, there are deficiencies in reciprocal techniques (experimental classes); namely:

- 1) Students who are seated together usually have the same ability, so that learners with below average capacity are also placed together and will receive more attention than other groups;
- 2) Students that are alienated find it difficult to accept lessons during the teaching and learning process, so that teachers should pay more attention to every individual in the classroom;
- 3) Learners may cheat by looking at questions from other groups, hence, teachers should pay more attention to learners' practices and behaviour.

Collaborative learning can provide opportunities that lead to successful learning practices, because the approach of collaborative learning involves the active participation of students and minimises differences between individuals. Collaborative learning has added to the momentum of formal and informal education from the two forces that meet: 1) the realisation through practice that living outside the classroom requires collaborative activities in real life; and 2) awareness of social interaction to realise meaningful learning [18].

Knowledge is constructed collaboratively between individuals, and the circumstances can adapt to each other. Cognitive processes directed towards initiating intellectual adaptation in a socio-cultural context. The adjustment process is equivalent to the intra-individual knowledge construction through the internal self-regulation process. Learners will have a different understanding of knowledge depending on their experience, and the perspective used in interpreting it [19].

According to Anuradha, collaborative learning will encourage students to think critically through discussions and critically evaluate other people's ideas [20]. But, both methods will be equally useful in acquiring factual knowledge. If the learning objectives to achieve are to improve students' critical thinking and problem-solving skills, then, collaborative learning is a very effective method.

Other research on collaborative practices in college suggests that learners can organise themselves to work productively by sharing roles/tasks and encouraging each other to construct knowledge cooperatively [21]. However, there are some differences between groups that can collaborate effectively with teams still struggling to share roles and duties for each of its members.

Learning is a system in which interaction exists between teachers and learners. Collaborative learning is a learning activity deliberately designed and implemented in pairs or groups. In collaborative learning, teachers plan the design of learning activities for students. In collaborative learning, all team members should have an equal contribution. When students work together in a cooperative task, they will gain knowledge.

## CONCLUSIONS

Creation of a conducive atmosphere needs to be accomplished, so that when learning students no longer feel anxious, are no longer afraid of participating, no longer perceive it as an obligation, but become conscientious in a comfortable and pleasant atmosphere. One way to create a relaxed and fun environment, and avoid boredom is to understand and implement student learning strategies, effective active communication and innovative learning models. A collaborative strategy is a learning strategy in which various students work together in small groups toward one goal. In this group, the students help each other. So, the collaborative learning situation has a positive dependency element for achieving success.

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