The Effect of Cooperative Learning and Learning Style on Problem-Solving Ability in Chemistry Learning

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Abstract—This research aims to know the influence cooperative learning model and learning style on problem-solving ability. This research is quasi-experimental research with factorial 2x3 designs. The samples were selected using cluster random sampling technique. Sample of this research was a tenth-grade student of two classes. The result of the descriptive analysis shows that the average and gain a score of the problem-solving ability of students who were taught cooperative learning model of STAD (student teams achievement division) type was higher than cooperative learning model of NHT (numbered head together) type. The average and gain a score of the problem-solving ability of students who have auditory learning styles higher than visual and kinesthetic. Inferential analysis results gained significant score was less than 0.05 which means there is the influence of cooperative learning model on problem-solving abilities. Inferential analysis results gained significant score was less than 0.05 which mean there was the influence of learning styles on problem-solving ability. Inferential analysis results showed a significant score of the cooperative learning model and learning styles on problem-solving ability. It means there was an interaction between the cooperative learning model and learning styles on problem-solving ability.

Keywords—cooperative learning, learning strategy, learning styles, problem-solving abilities

I. INTRODUCTION

The learning process is one factor in determining the success of students. The learning process is inseparable from the role of the teacher as an educator. The teacher is an essential component in the implementation of the standard educational process because the application of the education process depends on the teacher [1]. There are many factors that influence the success of learning, such as learning strategies, learning media, and student characteristics [2], [3]. In the present era, another important factor is the use of information and communication technology in learning. The teacher's ability to manage these factors becomes very important [4], [5].

The teacher strives to create the latest innovations in the learning process. The teacher can choose the right learning model in delivering learning material. Teachers as educators must also learn the learning styles of each student [6], [7]. The learning process will also be more directed starting with problems that must be solved by students. Issues that require students to be able to solve problems will encourage students to develop maximum thinking skills. Using a learning model that is appropriate to the learning style of students, is expected to make students able to solve problems that improve the learning process to be fun and the learning outcomes will be better.

Natural learning processes that are always used by teachers oppose participation and cooperation and interaction between students. Hope to compete between students is very low. Once approved, students are given questions by the teacher; students will overcome difficulties in completing them. This difficulty causes the minimum passing grade score to be taken by students to be low. Therefore, in the learning process, the teacher must involve students and active learning processes that can improve problem-solving and student learning outcomes. Student activity in learning shows student involvement. This involvement becomes an important part of learning motivation that can improve learning outcomes in accordance with the expected competencies.

The application of a learning environment that encourages students to be active is one way to improve learning performance. From many studies, cooperative learning is one of the learning strategies that can encourage this active learning. Learning models that involve students actively and can improve students' problem-solving skills are cooperative learning models. The cooperative learning model emphasizes teamwork to solve problems. Cooperative learning could meet the needs of students in critical thinking, solving problems and integrating knowledge with experience [8], [9]. Cooperative learning is not just learning the material, but students must also discover special skills called cooperative skills [10].

The results of research related to the application of cooperative learning have been carried out by many learning experts in various fields of science. There is optimism that this learning has an opportunity to increase learning outcomes when applied appropriately [11]-[13]. Cooperative learning has several types including STAD (Student Teams Achievement Division) and NHT (Numbered Heads Together). The main idea of STAD is to encourage students to encourage and help each other to master the skills taught by the teacher. STAD type cooperative learning model is a learning model that emphasizes the activities of students in groups of 4-6 people based on 6 steps: conveying goals and motivations, presenting information, organizing students in groups, guiding study groups, evaluation and appreciation [11], [14], [15]. NHT is a type of cooperative learning that is designed in groups of 4-6 people using numbers as the identity of each group member based on the steps namely: numbering, submitting questions, thinking together and giving answers [16], [17]. The purpose of this grouping is to provide

opportunities for students to be directly involved in the process of thinking and solving-problems [18].

The learning styles of students also influence increasing students' problem-solving abilities. Learning styles show how students learn. Learning styles are a benchmark for designing learning strategies in the learning process in the classroom [19]. Learning styles help students to be more focused and attentive to the lesson, which in turn will increase success in learning [20], [21]. Every student has a different learning style.

In general, when teachers teach they have not given attention to learning styles. In fact, students with different learning styles tend to receive knowledge differently. It is indeed not an easy thing to apply learning by paying attention to learning styles. There are three types of learning techniques namely visual learning styles, auditory learning styles, and kinesthetic learning styles.

Problem-solving skills will increase if students help each other and work together in solving problems given by the teacher. Problem-solving ability is also very closely related to the learning outcomes of students. A student with high problem-solving skills has a huge possibility to get proper learning outcomes, and vice versa.

One chemical material that requires problem-solving skills is stoichiometry. This material discusses concepts and formulas in solving problems. The emphasis on this material is still on the problem-solving skills using ideas so that students are less trained to solve problems. In addressing the issue, students tend to be passive and wait for the answers given by the teacher. When problems are presented in other forms, participants sometimes still have difficulty completing them.

Based on the description above, research was carried out with the aim of knowing the effect of STAD and NHT type cooperative learning models on problem-solving abilities; the effect of learners' visual, auditory and kinesthetic learning styles on problem solving abilities and the interaction between cooperative learning models and learning styles towards problem solving abilities.

The hypotheses in this study are as follow

- There is an influence of the type of cooperative learning on solving abilities.

- There is an influence of learning styles on problem-solving abilities.

- There is an interaction between the type of cooperative learning and learning styles in influencing problem-solving abilities.

II. METHOD

This type of research is a quasi-experimental study conducted at a senior high school at Maumere, Nusa Tenggara Timur, Indonesia in the second semester of the 2017/ 2018 academic year. The experimental design used is a 2x3 factorial design. This factorial design uses a manipulative independent variable learning model which is divided into two and attributive independent variables which are divided into three groups.

The population in this study was all students of tenth-grade. Sampling in this study was conducted using cluster random sampling to select two classes. The number of student at each class was 36 students. The first class was taught with cooperative learning models STAD and the second class was taught by NHT type cooperative learning models.

The instruments used in this study include

- Learning style questionnaire which is a standard questionnaire of 30 questions.

- Instruments of problem solving ability in the form of essays on Stoichiometry material as many as 8 items.

- Learning implementation observation sheet in the form of observation sheets made based on the syntax of each type of cooperative learning applied in the research sample class.

Technical data analysis consists of descriptive statistical analysis and inferential statistics. Descriptive statistical analysis was used to describe in general the problem-solving abilities of students in the subject matter of stoichiometry for each experiment class, which consisted of mean, median, standard deviation, range, highest, and lowest scores. Inferential statistical analysis is used to test the truth of the hypothesis proposed. The research data analysis was processed using the SPSS version 20.

III. RESULT AND DISCUSSION

Descriptive statistical analysis of students problem-solving abilities taught with the STAD type cooperative learning model and the NHT cooperative learning model in the Stoichiometry subject matter is presented in Table I.

TABLE I.   THE RESULT OF STUDENTS' PROBLEM SOLVING ABILITIES

Descriptive Statistics	STAD	NHT
N	36	36
Mean	81.13	76.60
Median	82.55	76.74
Variance	37.08	22.18
Std. Deviation	6.08	4.70
Range	14.96	15.12
Minimum value	72.24	69.76
Maximum value	87.20	84.88
N-gain	0.88	0.75

This table shows that the average value of students' problem-solving abilities taught by the model STAD type cooperative learning is higher. The median or middle scores of students who are trained with the STAD Cooperative learning model are higher, as well as the maximum value and the minimum value of students' problem-solving abilities. The range in the class taught by the STAD cooperative learning model is lower than the range in the lesson taught by the NHT cooperative learning model because the distance between the maximum and minimum values of the STAD class is closer. Variance values and standard deviations of the STAD class are more varied than the NHT class. The N-Gain amount of the two classes is in the high category. N-Gain scores from the lesson taught with the STAD type cooperative learning model are higher than those shown with the NHT type. Based on Table I, it can be said that students ' problem-solving abilities

taught by the STAD type cooperative learning model are higher than students' problem-solving abilities explained by the NHT type cooperative learning model.

From the results of this study, the score of problem solving ability can also be seen based on student learning styles. From these results can be compared how the influence of learning styles on problem solving abilities. Description of students' problem-solving abilities based on learning styles is shown in Table II.

TABLE II.　THE RESULT OF STUDENTS' PROBLEM SOLVING ABILITIES BASED ON LEARNING STYLE

Descriptive Statistics	Learning Style		
	Visual	Auditory	Kinesthetic
N	22	30	20
Mean	76.43	80.89	78.51
Median	73.33	80.23	79.07
Variance	36.19	31.64	26.83
Std. Deviation	6.01	5.62	5.18
Range	17.44	17.44	15.11
Minimum value	69.76	69.76	72.09
Maximum value	87.20	87.20	87.20
N-gain	0.77	0.85	0.82

The average value of the problem-solving abilities of students who have auditory learning styles is higher than visual and kinesthetic. Median or middle scores of students with acoustic learning styles are also higher than visual and kinesthetic. These three learning styles have the same maximum value. The minimum amount of students with kinesthetic learning styles is higher than visual and auditory. N-Gain scores from all three different learning styles and are in the top category. Students who have acoustic learning styles have higher N-Gain scores than visual and kinesthetic. Based on Table II, it can be said that the problem-solving abilities of students who have auditory learning styles are more senior than students who have a visual and kinesthetic learning style.

Visualization of problem-solving abilities based on cooperative learning models and learning styles is shown in Fig. 1.
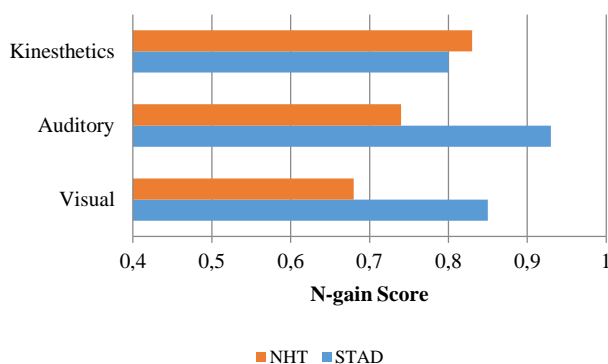

Fig. 1.　N-gain problem-solving ability score based on cooperative learning model and learning style.

From the figure, it can be seen that the highest N-gain score of the problem-solving ability in the class taught by the STAD was students who have auditory learning styles and visual learning styles and kinesthetic. In the class prepared with the cooperative learning model the NHT, the highest score of N-gain was students with kinesthetic learning styles

then auditory and visual learning styles. When compared to each class based learning style, the N-Gain value of the visual and auditory learning styles in the STAD class is higher than the NHT, and the average kinesthetic learning style in the STAD was lower than the NHT.

The results of descriptive statistical analysis showed that the average scores and N-Gain scores of students' problem-solving abilities taught with STAD type cooperative learning models were 81.13 and 0.88 higher than students who were taught by the NHT type cooperative learning model namely 76.60 and 0.75. The results of inferential analysis (α=0.05) obtained a significant value of 0.001, which means that H0 is rejected, so it can be concluded that there is an influence of cooperative learning models on problem-solving abilities. In the implementation of the STAD type cooperative learning model can make students better able to solve problems because of the quiz that is done at the end of the lesson. This quiz triggers students to continually practice until they can answer the questions given in Stoichiometry material.

The results of the descriptive statistical test showed that students who were taught with the STAD type cooperative learning model had an average score and N-Gain score that was 77.08 and 0.70 which was higher than the students who were taught by the NHT type cooperative learning model namely 66.00 and 0.59. The results of inferential analysis (α=0.05) obtained a significant value of 0.039, which means that H0 is rejected, so it can be concluded that there is an influence of cooperative learning models on learning outcomes. STAD type cooperative learning model provides a higher increase in learning outcomes compared to the NHT cooperative learning model. This is caused by the exercises that are carried out more often, namely with the quiz being conducted.

The statistical description of problem-solving abilities can be seen from the average and N-Gain scores of students who have auditory learning styles (80.89 and 0.85) higher than students who have kinesthetic learning styles (78.51 and 0.82) and visual learning styles (76.43 and 0.77). Based on the results of inferential analysis (α=0.05) obtained a significant value of 0.004, which means that H0 is rejected. The results of the post-hoc of Tukey HSD test also showed that there were substantial differences between the problem-solving abilities of students who had visual and auditory learning styles but did not differ significantly between students who had kinesthetic learning styles and visual and auditory learning styles. Differences in problem-solving abilities indicate that there is an influence of learning techniques on students' problem-solving abilities. Description of problem-solving abilities, average values and N-Gain scores reinforced by the results of hypothesis testing indicate that there is an influence of learning styles on problem-solving abilities.

The results of inferential analysis (α=0.05) obtained a significant value of 0.000, which means that H0 is rejected. In addition, based on the interaction graph and the Tukey HSD Post Hoc test between cooperative learning models and learning styles shows the intersection of lines between collaborative learning types and learning techniques and there are differences between the differences in problem solving abilities of students who have visual, auditory and kinesthetic learning styles that taught with the STAD type cooperative learning model with problem solving abilities of students who

have visual, auditory and kinesthetic learning styles shown by the NHT type cooperative learning model.

The interaction between two independent variables (learning strategies and learning styles) can be seen from the graph of the average value of the two variables. Fig. 2 shows whether the two variables interact with each other. From the graph, it can be explained that students who have an auditory learning style have higher problem-solving abilities than the visual and kinesthetic learning styles in the class taught by the STAD type cooperative learning model. In classes taught by the NHT type of cooperative learning model, students who have higher problem-solving abilities are students who have kinesthetic learning styles rather than auditory and visual. The results of descriptive and inferential analysis and interaction charts show that there is an interaction between the cooperative learning model type STAD and type NHT with students who have visual, auditory and kinesthetic learning styles in influencing students' problem-solving abilities.
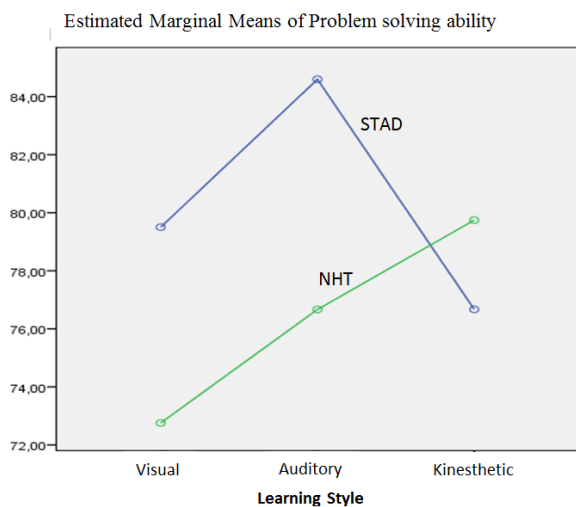

Fig. 2. Interaction of cooperative learning types and learning styles in affecting students' problem solving abilities.

In this study the learning style that is more dominantly used by the class taught using the STAD type cooperative learning model is the auditory learning style. In the implementation of this learning style provides an opportunity for students to listen to more knowledge from the delivery of material, discussions conducted and the birth of the opinions of group friends or other groups. So, students who have an auditory learning style are better able to solve problems given than students who have a visual and kinesthetic learning style. The dominant learning style used in the class taught by the cooperative type NHT learning model is the kinesthetic learning style. The implementation of this learning model provides opportunities for students who have a more active kinesthetic learning style in problem-solving because each student has the same possibility to present the results of their group problem-solving.

From Fig. 2, it can be seen that for the learning style, the highest score is the auditory and the lowest on kinesthetic. This result certainly cannot be generalized as a tendency. In this case there is a possibility influenced by how the teacher interacts with students when applying certain learning strategies [21], [22]. In theory, students with certain learning styles taught with appropriate strategies will achieve learning performance with students with other learning styles taught with appropriate strategies. This situation is also related to how students perceive learning. Positive perceptions tend to get good learning outcomes [23]. In other words, cooperative learning strategies applied to both STAD and NHT tend to benefit students with auditory, visual and kinesthetic learning styles in sequence.

IV. CONCLUSION

Based on the results and discussion, it can be concluded that there are influences of cooperative learning models and learning styles on problem-solving abilities. Students taught with STAD tend to increase problem solving skills compared to students with NHT. Sequentially, students with auditory learning styles tend to increase higher than students with visual or kinesthetic learning styles. In this case, there is an interaction between learning strategy and learning styles to problem-solving abilities.

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