Comparison of cooperative learning types in physics teaching: a short literature review

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A short literature review has been carried out on the comparison of cooperative learning types in physics learning. The purpose of this literature review is to discuss the type of cooperative learning that is effectively used in terms of the dependent variable measured. The method used in this study is literature review. Literature review is conducted by searching for keywords related to the theme raised. This keyword search is done through Google Scholar, Base, and Core search engines. A number of 27 articles have been retrieved that match the keywords and have been screened with limitation on the year of publication, namely the last 10 years. Through this literature review, it is obtained that the effective type of cooperative learning used depends on the measured (dependent) variables. The GI type of cooperative learning model is more effective for improving physics learning outcomes, scientific attitudes, and learning activities. The STAD type is better at increasing students' learning motivation and cognitive learning outcomes. The NHT type is better at improving students' affective, cognitive learning outcomes, and critical thinking skills. The Jigsaw type is effective in improving problem-solving abilities, performance, attitude, and retention in physics.

Keywords: Cooperative learning; cooperative learning types comparison; physics learning.

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1. Introduction

Physics is a subject that studies natural phenomena and is related to the application of various scientific concepts. Studying physics is important as a means to develop thinking skills and their applications that can be found in everyday life. The findings from the application of physics can be learned by students through the learning process in class. The physics learning process becomes more meaningful when the teacher is able to present the learning process in accordance with the demands of the curriculum [1]. These demands are to create learning activities by involving the active role of students so that they have adequate knowledge and skills [2]. This leads to a change in the learning paradigm, which is originally a teacher-centered to student-centered learning process [3].

The learning model applied in the classroom is one of the factors that influence the learning process [4,5]. The learning and management models used by the teacher greatly influences the quality of learning from the aspect of student activity. The quality of learning includes activeness, enthusiasm for learning, motivation to learn, self-confidence, and learning outcomes [6,7].

One of the learning models that can be applied in the learning process is the cooperative learning model [8]. In principle, cooperative learning is a method whereby students work together in (small) groups to achieve common and also individual learning goals. This method is recommended to be applied in physics learning as it embodies many advantages, including foster physics learning and critical thinking skills, develop communication skills, improve self-regulated learning, and promote academic motivation [9]. However, there are also challenges facing this method, *i.e.*: time-consuming, lack of cooperative skills, and solution dependence upon the group [9]. As there are many kinds of group activities and ways in manifesting the cooperative activities, hence it is natural that there are many types of cooperative learning model, such as student teams' achievement division (STAD), think pair share (TPS), jigsaw, numbered head together (NHT), teams' games tournament (TGT), group investigation (GI), two stay two strays (TSTS), make a match (MaM), example non example (ENE), and snowball throwing (ST).

There have been many studies that discuss the implementation of cooperative learning models. However, several findings were obtained in the form of comparisons between two and three types of cooperative learning models. Therefore, a literature study is carried out to compare ten types of cooperative learning that are applied in physics teaching. Thus, the purpose of this literature review is to discuss the type of cooperative learning that is effectively used in terms of the dependent variable measured.

2. Research method

The research design used was a literature review. A literature review study is a method used to collect data sources on a particular topic. Literature review is a systematic, explicit, and reproducible method. The use of the literature review method was to identify, evaluate, and synthesize research results and

TABLE I. Examples of high relevant articles in a synthesis matrix.

Title	Methods	Findings	Year
Differences in student learning outcomes using the TPS cooperative learning model with the TSTS type in class XI IPA SMA Negeri 4 Banjarmasin.	The research method was quasi-experimental. The physics topic used was fluid dynamics.	The findings showed that there were significant differences in learning outcomes using the TPS and TSTS cooperative learning types. Based on the findings, learning using the TPS had higher learning outcomes than using the TSTS.	2017
Differences in the effect of STAD type and jigsaw type cooperative learning model on physics learning outcomes in view of student learning motivation.	The research method used was quasi-experimental. The dependent variables studied were student motivation and physics learning outcomes compared to students outcomes in the sound topic.	Based on the findings, it was found that students who were taught using the STAD type produced higher who were taught using the jigsaw type. However, the interactions and links between learning motivation and learning models do not appear in the learning outcomes obtained by students.	2015
Comparison of physics learning outcomes for class X students using the GI and TPS learning models at Purwodadi High School.	The research method used was comparative with experimental method. The physics topics used were energy and electric power.	The findings showed that there were significant differences in student learning outcomes between the GI and TPS types in the topics of energy and electrical power in class X Public Senior High School Purwodadi. The results of studying physics using the GI type was significantly higher than the TPS type.	2020

thoughts of previous researchers [10]. The review results in this study went through four stages, namely (1) selecting topics to be reviewed, (2) tracing and selecting relevant articles, (3) analyzing and synthesizing articles, and (4) organizing the review article. The collection of literature sources was obtained from various sources through studies of National and International journals by utilizing Google Scholar, Base, and Core search engines. The keywords entered included: cooperative learning model, types of cooperative learning, and comparisons of cooperative learning types. 27 articles were found that match the keywords and have been screened with a limitation on the year of publication, namely the last 10 years. The articles used were selected and synthesized with high relevance for review. The article synthesis technique used a synthesis matrix. The synthesis matrix was used to organize literature sources and interpret them with a unique integration of research findings. Examples of articles with high relevance were given in Table I.

3. Results and analysis

Here, we loosely compare ten types of cooperative learning model, *i.e.*, STAD, TPS, jigsaw, NHT, TGT, GI, TSTS, MaM, ENE, and ST. Hence, a pie chart of the ten types of cooperative learning model is obtained based on Google Scholar, Base, and Core search engines. The pie chart of the number of search results for the ten types of cooperative learning model can be observed in Fig. 1.

Based on the literature review and Fig. 1, it can be shown that the types of cooperative model that are widely used in physics learning are the ENE and GI types. Both have the largest percentage of the ten types of cooperative learning

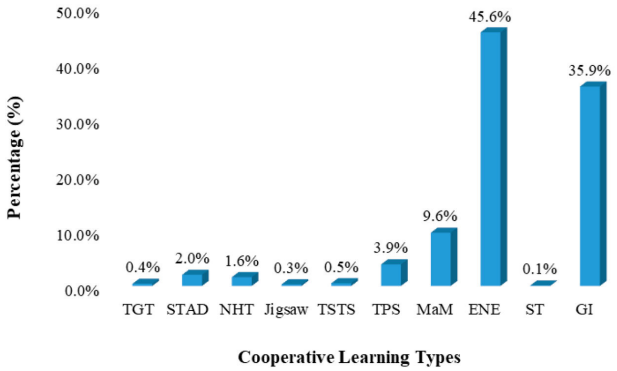

FIGURE 1. Number of search results for cooperative learning model types.

TABLE II. The synthesis results.

No	Authors	Methods	Findings
1	[11]	The research method was quasi-experimental. The physics topic was fluid dynamics.	The findings showed that there were significant differences in learning outcomes using the TPS and TSTS types. Based on the findings, learning using the TPS type had higher learning outcomes than using the TSTS type.
2	[12]	The method used in this study was the experimental method. The sample in this study was obtained using the purposive sampling. The physics topic used was straight motion.	The findings showed that the increase in student learning outcomes in physics at SMA PGRI 2 Palembang using the NHT type was higher than the STAD type.
3	[1]	The research method used was quasi-experimental. The dependent variables were student motivation and physics learning outcomes in the sound topic.	It was found that students who were taught using the STAD type produced higher learning outcomes compared to students who were taught using the jigsaw type. However, the interactions and links between learning motivation and learning models did not appear in the learning outcomes obtained by students.
4	[13]	The research method used was quantitative method using experiments. This study used the pretest -posttest control group design. The physics topics used were vibrations and waves.	The findings showed that there were significant differences in physics learning outcomes between STAD and TGT types in class VIII Air Lesing Public Junior High School. In general, the learning outcomes of students who were taught using the STAD type were better.
5	[14]	This was an experimental study. The research design used was the nonequivalent pretest-posttest control group design.	The findings showed that STAD and jigsaw types have different effectiveness effects on students' problem-solving abilities. The jigsaw type had more influence on the effectiveness of the learning process compared to the STAD type.
6	[15]	The research method used was the experimental method. Sampling was done by means of cluster random sampling. The physics topic used was light.	The findings showed that there was no difference in the effect of using the jigsaw and TGT types on physics learning outcomes. In addition, there was no difference between the jigsaw and TGT types concerning higher order thinking skills (HOTS).
7	[4]	This research method used was quantitative approach with descriptive and comparative research type. The physics topic used was elasticity.	The findings showed that there was a significant increase in students' critical thinking skills with the jigsaw and TSTS types. However, there was no significant difference in the critical thinking skills of students taught by the jigsaw and TSTS types.
8	[16]	This research method used was experimental with posttest-only control research design. The physics topic used was temperature and heat.	The findings showed that there was a significant difference between the TPS and TGT types. The TGT had a higher score compared to TPS in improving physics learning achievement.
9	[17]	The method used in this study was quantitative method. The experimental approach was used. The physics topic used was elasticity.	The findings showed that there was no difference in the learning outcomes of students taught using the jigsaw and STAD types.

No	Authors	Methods	Findings
10	[18]	The method used was quasi-experimental with a research design of matched group (M-G) pattern experiment.	The findings showed that the jigsaw type was more influential on students' cognitive learning outcomes compared to the MaM type.
11	[19]	The method used was the experimental method. The research design used was posttest only control group design. The physics topic used was straight motion.	The results showed that the learning outcomes of cognitive physics with the STAD type were higher than the TSTS type.
12	[5]	The research method used was the quantitative approach with descriptive and comparative research type. The research design used was the static group pretest-posttest design. The physics topic used was elasticity.	The findings showed that the cognitive, affective, and psychomotor learning outcomes of students with the jigsaw and TSTS types had increased. However, there was no significant difference between students who used the jigsaw and TSTS in cognitive, affective, and psychomotor learning outcomes.
13	[20]	The research method used was the pre-experimental method.	The findings showed that there was no significant difference in the ability to cooperate and think creatively by applying the TPS and TSTS types. Both were included in the high category, meaning that they were able to improve the abilities to cooperate and think creatively.
14	[21]	This study used the experimental research method. The experimental design used was quasi-experimental with pretest-posttest control group design. The learning model used was the NHT, ENE, and ST types.	The findings showed that there were influences of the NHT, ENE, and ST types on the learning outcomes of students' cognitive and affective aspects. Each class with each learning model had seen an increase in cognitive and affective aspects. The learning model that had the most influence on the achievement of learning outcomes in the cognitive aspect was the NHT followed by the ENE, and finally the ST. Moreover, the learning model that had the most influence on the achievement of affective aspect learning outcomes was the NHT, followed by the ST, and finally the ENE.
15	[22]	This study used the quasi-experimental method with qualitative data correlation.	STAD, jigsaw II, and TGT were considered effective to improve the achievement and understanding of physics concepts. The concept of systematic learning, theoretical explanation, discussion of questions, and evaluation also influenced the increase in understanding of the concept of physics.
16	[23]	This study used a quasi-experimental method.	The GI and NHT types can improve learning outcomes. The GI had a higher score than the NHT model.
17	[24]	The research method used was a comparative study with experimental research method. The physics topics used were energy and electric power.	The findings showed that there were significant differences in student learning outcomes between the GI and TPS types in the topics of energy and electrical power in class X of Purwodadi Public Senior High School. The results of studying physics using the GI type was significantly higher than the TPS type.
18	[25]	The research method used in this research was the posttest only control group. The physics topic being taught was optical instruments.	The findings showed that there were differences in physics learning outcomes in class X between those taught using GI and TSTS. The average results of the GI class were greater than those of the TSTS classes.

No	Authors	Methods	Findings
19	[26]	This research method used a quasi-experimental design with a counter balanced design.	The findings showed that there were differences in the learning outcomes of students taught by GI and STAD. The results of studying physics using the GI type were higher than the STAD type.
20	[27]	This was quantitative research using the experimental method. The physics topic used was optical instruments.	The findings showed that there were differences in the effect of the GI and STAD on students' physics learning achievement on the topic of optical instruments. Learning by using GI provided higher physics learning achievement results compared to STAD. However, there was no interaction between the cooperative learning model and scientific attitudes towards student achievement.
21	[28]	This research used the experimental method. The physics topic used was motion.	The findings showed that the GI had a better influence on students' physics cognitive abilities on the topic of motion than the STAD.
22	[29]	The research method used was the randomized control group pretest-posttest design. The physics topics used were elasticity and Hooke's law.	The findings showed that there were significant differences in students' critical thinking skills between students who were taught using the NHT and GI. The results showed that the NHT produced higher scores than GI.
23	[30]	The method used in this study was the pretest-posttest experimental group design.	The findings showed that students taught with STAD and LTM both significantly and effectively improve academic achievement, retention, and student learning motivation.
24	[31]	The method used was a quasi-experimental study using a non-randomized and non-equivalent pretest-posttest control group design.	This study had delved into three types of computer-supported cooperative learning strategies, *i.e.*, STAD, jigsaw II, and TAI as a way to overcome poor performance in physics at the senior secondary school level in Nigeria. All three computer-supported cooperative learning strategies had a positive effect on student attitudes towards physics compared to individualized computer instruction (ICI). However, jigsaw II is the only computer supported cooperative learning strategy to have a positive effect on student performance compared to ICI. Furthermore, cooperative learning strategies did not increase retention compared to ICI.
25	[32]	The study was based on quantitative approach and the pretest-posttest control group design was used.	The findings showed that for effective teaching, both cooperative learning types *i.e.:* STAD and jigsaw II proved to be better than the traditional method of teaching. It was inferred that these techniques enhance learning. It provided more interaction, cooperation, and made students more active. It was seen that students taught through cooperative learning techniques showed better results in their overall academic performance as compared to the students of the control group. All students including high and low-achievers of treatment and comparison groups were found to be significantly different in the posttest.
26	[33]	The research design used was quasi-experimental with crossover-repeated measurements design within two sessions.	The results appeared to show a better improvement in students' achievement in the more structured individual responsibility (jigsaw type) group compared to the least structured individual responsibility (STAD type) group.

No	Authors	Methods	Findings
27	[34]	A quasi-experimental study of of a non-randomized and non-equivalent pretest-posttest control group design was employed in this study. The physics topics used were equilibrium of forces and simple harmonic motion.	Findings indicated that there was a significant difference in the performance of the groups. In addition, students' gender had no influence on their performances. Achievement levels had significant influence on students' performance in cooperative settings. STAD and jigsaw II computer-supported cooperative strategies were more effective in teaching the equilibrium of forces and simple harmonic motion concept of physics.

TABLE III. Comparison results of two or more types of cooperative learning model.

No	Authors	Comparison Results	Dependent Variables
1	[11]	TPS > TSTS	Physics learning outcomes
2	[12]	NHT > STAD	
3	[13]	STAD > TGT	
4	[17]	jigsaw = STAD	
5	[23]	GI > NHT	
6	[24]	GI > TPS	
7	[25]	GI > TSTS	
8	[26]	GI > STAD	
9	[5]	jigsaw = TSTS	
10	[1]	STAD > jigsaw	Students learning motivation
11	[14]	jigsaw > STAD	Physics problem-solving skills
12	[15]	jigsaw = TGT	HOTS
13	[4]	jigsaw = TSTS	Critical thinking skills
14	[16]	TGT > TPS	Physics learning achievements
15	[18]	jigsaw > MaM	Cognitive learning outcomes
16	[19]	STAD >TSTS	
17	[20]	TPS = TSTS	Creative thinking and collaboration skills
18	[21]	NHT > ENE > ST	Affective and cognitive learning outcomes
19	[22]	STAD = jigsaw = TGT	Achievement of students on science competition
20	[27]	GI > STAD	Scientific attitude
21	[28]	GI > STAD	Learning activity
22	[29]	NHT > GI	Critical thinking skills
23	[30]	STAD = LTM	Achievement and motivation in physics
24	[31]	jigsaw > STAD = TAI	Performance, attitude, and retention in physics
25	[32]	STAD = jigsaw	Performance in physics
26	[33]	jigsaw > STAD	Achievement in learning science
27	[34]	STAD = jigsaw	Performance in physics

Note: ">" means perform better than; and "=" means perform equally well with.

model, namely 46% for the ENE type and 36% for the GI type. The least percentage is the ST type learning model with a percentage of 0.1%. In this case, it can be implied that the ENE and GI types of cooperative learning model are more familiar and often used in schools, especially in physics learning. From Fig. 1, we then focus on a smaller number of 27 articles, which discuss the comparison of the aforementioned ten cooperative learning types added with two additional types, *i.e.*, team assisted individualization (TAI) and learning together model (LTM). These articles are then synthesized but not limited upon the percentage obtained for each type of cooperative learning in Fig. 1. The results of the synthesis can be observed in Table II. Hence, the "Findings" on the fourth column of Table II show the comparison results of various cooperative learning types depending upon the dependent variables studied.

Based on the details of the comparison results in Table II, several findings are obtained concerning some types of cooperative model that have been studied. The GI type is more effectively used to improve learning outcomes [23-26], scientific attitudes [27], and learning activities [28] compared to other types of cooperative models. In the GI type, the steps taken using this model are very good and detailed, including choosing a topic; cooperative planning; implementation; analysis; and presentation. In this case, learning becomes student-centered so that students play an active role during learning in solving problems, making decisions, researching, and presenting. Thus, it can improve learning outcomes, scientific attitudes, and student learning activities. The STAD type of cooperative learning model is better at increasing student learning motivation [1] and cognitive learning outcomes [19]. In the STAD type cooperative learning model, the teacher guides students to master the subject matter and then discussions are held with students who are good at explaining to the group members who do not understand so that this type of learning can increase students' motivation. In addition, the implementation of STAD makes students play an active role in expressing their ideas and opinions, so that students can improve their cognitive learning outcomes. Furthermore, the NHT type cooperative learning model is better at improving students' affective and cognitive learning outcomes [21] and critical thinking skills [29]. The NHT type learning model makes students to be serious in conducting discussions. This causes the value of cooperation, which is part of the affective aspect, to be higher because students share knowledge with each other to understand the material, which can improve students' cognitive outcomes. In addition, the NHT learning model is a model with simple stages so that it can be applied properly in learning, especially in improving students' critical thinking skills. Finally, the jigsaw cooperative learning model is effective in improving problem-solving abilities [14], performance, attitude, and retention in physics [31]. In this case, the jigsaw type requires students to be a good communicator to convey information to other students. Hence, performance and attitude of students in physics learning are improved. Therefore, the description above shows that the effectiveness of using each type of the cooperative learning model does not depend on the physics topic taught by the teacher, but it is influenced by the dependent variable to be measured.

Moreover, we summarize the findings obtained from the 27 articles that are appropriate and relevant to the topics discussed. Here, we directly compare two or more types of cooperative learning model based on the dependent variables. The comparison results can be observed in Table III. On the dependent variable of physics learning outcomes, it may be observed that the best used cooperative learning type is the GI. This is because the GI is one of the simplest types of cooperative learning to be conducted, which emphasizes heterogeneity, democracy, and the ability of the individual member in a group. Other dependent variables also show different results for different type of cooperative learning conducted. However, more comparisons of the types of cooperative learning are needed for these dependent variables so as to obtain the best type of cooperative learning used for each dependent variable.

4. Conclusion

A short literature review on the comparison of the types of cooperative learning model has been carried out. There are ten types of cooperative learning model that have been studied, namely STAD, TPS, jigsaw, NHT, TGT, GI, TSTS, MaM, ENE, and ST. The findings show that the performance of each cooperative learning type depends on the measured variables (dependent variables). The GI type of cooperative learning model is more effective for improving physics learning outcomes, scientific attitudes, and learning activities. The STAD type of cooperative learning model is better at increasing student learning motivation and cognitive learning outcomes. The NHT type cooperative learning model is better at improving students' affective, cognitive learning outcomes, and critical thinking skills. Furthermore, the jigsaw cooperative learning model is effective in improving problem-solving abilities, performance, attitude, and retention in physics. More comparisons of the cooperative learning types are needed to determine the best type of cooperative learning for each dependent variable. Finally, it is recommended for future studies to make ST as a new line of research as it is the least used type of the cooperative learning model.

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