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Application of Jigsaw Type Cooperative Learning Model to Improve Conceptual Knowledge and Problem Solving Ability of Senior High School Students

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Abstract
This study proves that the Jigsaw type cooperative learning model can improve the conceptual knowledge of students on thermochemistry material, which is a learning model that has an influence on improving students' conceptual knowledge of thermochemistry. It aims to improve students' conceptual knowledge and problem solving ability through the application of the Jigsaw type cooperative learning model, taking into account the students' basic mathematics ability level which is classified into three categories: low, medium, and high. This research used quasi-experiment method with pretest-posttest control group factorial design. The subjects of the study were students of class XI IPA at SMA Negeri 06 Bombana, Bombana Region. Data were obtained through conceptual knowledge test, problem solving ability test, and student response questionnaire. The results showed that the conceptual knowledge of students who followed the Jigsaw type cooperative learning model was quantitatively higher than that of students who followed the conventional learning model. The results showed that the conceptual knowledge of students who followed Jigsaw cooperative learning was quantitatively higher than that of students who followed conventional learning. The same applies to problem solving ability, where students with the Jigsaw model showed quantitatively higher results compared to conventional learning students. the increase in conceptual knowledge was greater in the Jigsaw group compared to conventional learning. The level of students' basic mathematics ability did not affect the increase in conceptual knowledge, but did affect the increase in problem solving ability. Students gave positive responses to the Jigsaw type cooperative learning model, stating that this model was fun, easy to follow, and increased learning motivation.

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INTRODUCTION

Chemistry as a natural science has complex characteristics and a high level of difficulty, as seen from the object of study, how to obtain knowledge, and the application of chemistry in life. At the SMA/SMK level, chemistry studies substances including composition, structure, properties, changes, dynamics, and energetics. This complexity makes chemistry lessons considered difficult by some teachers and students. (Darsono, 2000), especially because of the many abstract concepts such as atomic structure, substance composition, and chemical bonding.

Thermochemistry is a part of chemistry that discusses changes in the heat of a substance that accompanies a chemical reaction or in other words, studies the relationship between heat and chemical reactions. Thermochemical material is material that most students find difficult to understand. The conventional learning model applied by the teacher makes students passive in learning where students only see and listen to the teacher delivering the subject matter. This can make students bored and not interested in following the subject matter taught so that students do not understand the subject matter. Thus, students find it difficult to solve the problems they face in learning.

Thermochemistry, one of the materials studied in grade XI, discusses the energy released or absorbed in chemical reactions. According to Brady (2006), thermochemistry provides useful applications of energy as well as an understanding of the nature of matter. However, students' learning outcomes on this material tend to be low. Chemistry teachers at SMAN 01 Bombana confirmed that thermochemistry is a difficult subject for students, as supported by Syam (2015), who mentioned the high complexity of this concept. Understanding thermochemistry requires quantitative ability and conceptual knowledge. Some students only memorise equations without understanding their meaning, so they have difficulty choosing problem-solving strategies. Hung and Jonassen (2006) emphasise that conceptual understanding greatly influences the success of problem-solving strategies. In addition, the conventional and teacher-centred learning process is another obstacle. This process is not in accordance with the Process Standard of Government Regulation No. 19 of 2005, which requires learning to be interactive, inspiring, fun, and encourages active student participation. Overcoming this difficulty can be done by developing learning models that increase students' mental activity, such as cooperative learning. This model emphasises critical thinking and problem solving skills, which in turn can improve conceptual knowledge. According to Fahyuddin (2014), problem solving involves schema construction in the cognitive process, so students who are able to construct new meanings will increase conceptual knowledge and problem solving ability.

Jigsaw type co-operative learning model is one of the effective approaches. In this model, students work together in small groups to learn and are responsible for their group's learning. This model improves students' interaction, communication and motivation, and enables them to understand difficult material, such as thermochemistry. Arends (2008) explains that in Jigsaw type, each student is responsible for learning and teaching the material to their group members, increasing active engagement and conceptual knowledge. The Jigsaw type cooperative learning model applied in this study has advantages compared to other cooperative models, where students are given the trust and responsibility to understand a certain part of the learning material. Furthermore, the material is taught back to their group mates which will make students collaborate more with their group mates both in the original group and in the expert group. This gives more opportunities for students to solve problems so that they understand the lesson better. Thus, this learning model allows to improve students' conceptual understanding and problem solving skills.

The results of research relevant to this study include Tran and Lewis (2012), who concluded that students in the experimental group who received the Jigsaw type cooperative learning model showed higher improvement than students in the control group who had been taught through conventional-based learning. Similarly, Erlianingsih (2009) reported that the Jigsaw-type co-operative learning model was more effective in improving conceptual knowledge of rotational dynamics when compared to CIRC-type co-operative learning.

Similar to the results of Harskamp and Ding's (2006) study, it is stated that learning problem solving collaboratively can improve students' problem solving ability compared to individual learning. Likewise, the results of Prastini's study (2014), which reported that the Jigsaw type cooperative learning model with game variations can improve the problem solving ability of students in Magelang.

Thermochemistry, with subtopics such as heat relations and chemical reactions, is suitable to be taught using the Jigsaw model. Students can work together to understand abstract concepts and complete calculations, thus improving problem-solving skills and conceptual knowledge. Haetami and Supriadi (2010) showed that the application of Jigsaw in chemistry can improve students' activity and learning outcomes. Another study by Tran and Lewis (2012) also proved that Jigsaw improved students' achievement retention and attitude. However, there are some disadvantages of applying Jigsaw, such as limited time, dominance of certain students in discussions, and lack of responsibility of some students. To overcome these problems, adaptation and good classroom management are necessary.

Another factor that influences learning thermochemistry is basic maths skills. This ability is an important prerequisite in understanding quantitative chemistry concepts, such as thermochemistry. Bangash and Mustafa's (2002) study showed that students' difficulties in solving chemical problems were caused by weak mathematical understanding. Tai et al. (2006) also stated that maths scores are a predictor of success in learning chemistry. This confirms the importance of maths skills in supporting the mastery of chemistry concepts. Based on the description above, the Jigsaw-type cooperative learning model has significant advantages in improving students' conceptual knowledge and problem-solving skills. Therefore, this study was conducted to evaluate the application of the Jigsaw model on thermochemistry material in high school.

Formulation of Problems

The formulation of the problem in this study is:

1. What is the description of the improvement of conceptual knowledge and problem solving ability of students after the application of Jigsaw type cooperative learning model and conventional learning on thermochemistry material, viewed as a whole and based on the level of basic mathematics ability of high school students?
2. Do students who received the Jigsaw type cooperative learning model show better conceptual knowledge and problem solving skills than students who received conventional learning on thermochemistry, both overall and based on the basic mathematics ability level of high school students?
3. Does the level of basic mathematics ability of high school students affect the improvement of students' conceptual knowledge and problem solving skills in thermochemistry?
4. Is there an interaction between the level of basic mathematics ability and learning model (cooperative Jigsaw type and conventional) on the improvement of conceptual knowledge and problem solving ability of high school students on thermochemistry?
5. How do students respond to the application of the Jigsaw type cooperative learning model in the experimental class?

RESEARCH METHOD

This study used a research approach with the method of quasi experiment with the research design used is factorial design using comparison class (Sugiyono, 2010). The population in this study is all students of class XI IPA SMAN 06 Bombana, while the sample in this study is students of class XI IPA SMAN 06 Bombana registered in the odd semester of the academic year 2015/2016 consisting of 2 classes with a total of 41 students who are distributed in parallel, then the sample is taken purposive sampling method so that the research sample is class XI IPA 1 as an experimental class that will be taught using cooperative learning model type Jigsaw and class XI IPA 2 as a control class that will be taught using conventional learning.

The main instruments that will be used in this study include: 1) conceptual knowledge test; 2) problem solving ability test; and 3) basic mathematics ability test. The three instruments will be developed based on the analysis of Thermochemistry learning objectives. The learning objectives will be translated knowledge dimension and cognitive process dimension (Anderson and Krathwohl, 2001). The type of data in this research is primary data. Primary data is data obtained or collected by researchers directly from the source. Data collection techniques are ways to obtain data that support the achievement of research objectives. In this study, the data collection techniques used are written tests in the form of test descriptions that are useful for knowing conceptual understanding and problem solving skills, observation sheets that are useful for observing the ongoing Thermochemistry learning process, questionnaires that each student fills out a questionnaire according to the actual conditions where this questionnaire has no consequences with the assessment so that students are expected to be honest in filling it out, and student worksheets carried out in the implementation of learning.

This study was conducted at SMAN 06 Bombana, Bombana Regency, Southeast Sulawesi Province from September to November 2024 odd semester of the 2024/2025 academic year, XI IPA 2 class (control class) and XI IPA 1 class (experimental class). The data collection technique used was primary data consisting of: Conceptual Knowledge data, Problem Solving Ability data, Basic Maths Ability data, and data on student responses to the application of the Jigsaw type cooperative learning model.

RESULTS AND DISCUSSION

Conceptual Knowledge Results

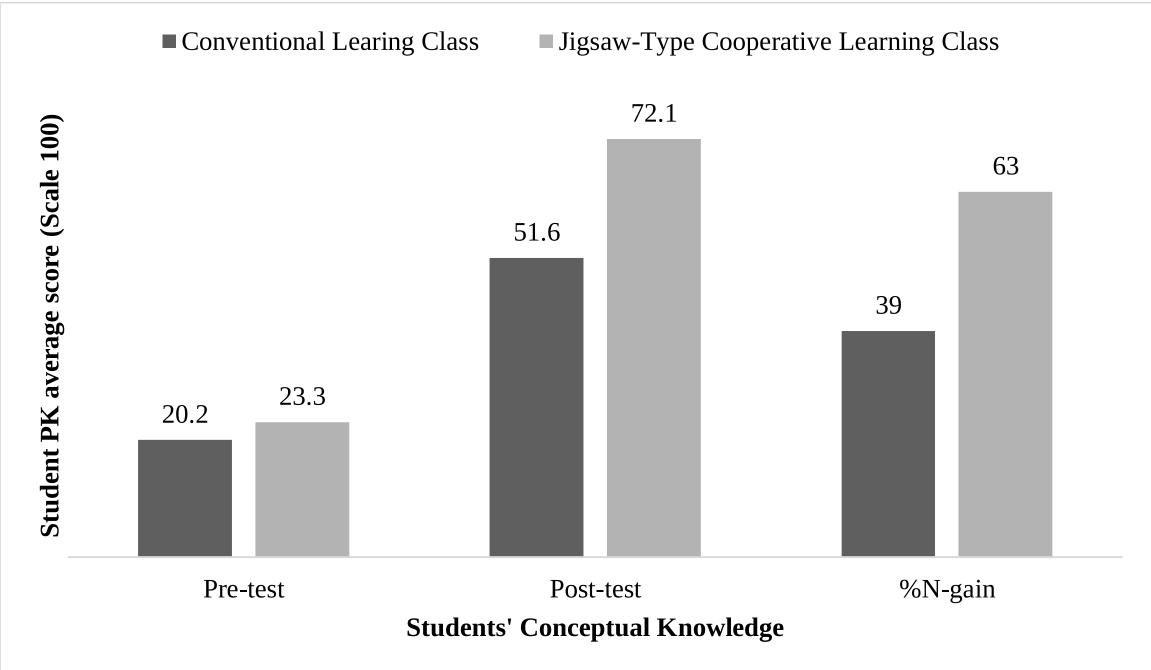

Figure 1. Graph of the average pre-test, post-test and %N-gain conceptual knowledge scores for each model learning

The graph of the average value of *pre-test*, *post-test,* and *% n-gain* of students' conceptual knowledge on Thermochemistry material can be seen in Figure 1. The average value of the *pre- test* of students' conceptual knowledge is normally distributed and homogeneous, then the value of $t_{hit} = 0.989$ and $t_{table} = 1.685$ is obtained. Since the value of $t_{(hit)} < t_{tab}$, then H_0 is accepted so it can be concluded that the mean value of conceptual knowledge *pre-test* of experimental class students and control class students is not significantly different. In other words, both groups of students have the same initial conceptual knowledge on Thermochemistry material. The graph of the average value of *pre-test, post-test,* and *% n-gain* of students' conceptual knowledge based on the level of basic mathematics ability on Thermochemistry material can be seen in Figure 2.

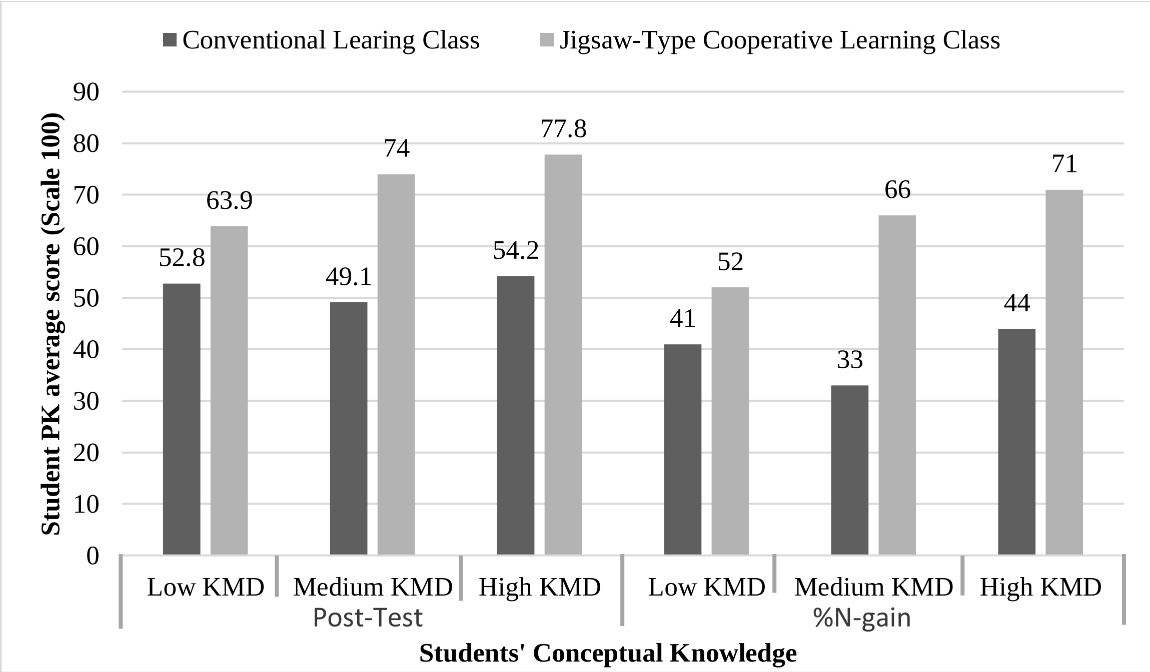

Figure 2. Graph of mean post-test score and %n-gain of conceptual knowledge based on basic mathematics ability level and both learning models.

The post-test results showed that the conceptual knowledge of students who received the Jigsaw type cooperative learning model was quantitatively higher than that of students who received conventional learning at various levels of basic mathematics ability. The following is the average value of students' conceptual knowledge post-test based on the basic mathematics ability level (from a scale of 100).

The difference in the improvement of students' concept understanding between learning models and basic mathematics ability levels can be explained from the distribution of N-gain categories of understanding, namely the number of students who obtained N-gain of concept understanding in the low category at three levels of basic mathematics ability in conventional learning more than the *Jigsaw* cooperative learning in the same category. In contrast, the number of students with high *N-gain* of concept understanding at three levels of basic mathematics ability in conventional learning was less than that of *Jigsaw* cooperative learning in the same category. This difference indicates that students with high concept understanding ability at low, medium and high basic mathematics ability levels are better off with *Jigsaw* cooperative learning compared to conventional learning. These results indicate that the Jigsaw type cooperative learning model is able to improve students' conceptual knowledge at all levels of basic mathematics ability compared to conventional learning.

Jigsaw-Type Cooperative Learning Model	Conventional Learning
1. Low Basic Mathematics Ability: 63,9 2. Moderate Basic Mathematics Ability: 74,0 3. High Basic Mathematics Ability: 77,8	1. Low Basic Mathematics Ability: 52,8 2. Moderate Basic Mathematics Ability: 49,1 3. High Basic Mathematics Ability: 54,2

Table 1 Description of *N-gain* of conceptual knowledge on several dimensions of cognitive process, basic mathematics ability level and learning model

Dimensions of Cognitive Processes	Knowledge Conceptual	Low Basic Mathematics Ability		Moderate Basic Mathematics Ability		High Basic Mathematics Ability	
		Conv. Learning	Jigsaw-Type Coop. Learning Model	Conventional Learning	Jigsaw-Type Coop. Learning Model	Conv. Learning	Jigsaw-Type Coop. Learning Model
Understand	*Mean*	0,44	0,51	0,43	0,67	0,56	0,89
	SD	0,35	0,34	0,21	0,26	0,16	0,17
Apply	*Mean*	0,32	0,53	0,27	0,68	0,11	0,53
	SD	0,24	0,36	0,35	0,32	0,39	0,42
Analyze	*Mean*	0,39	0,38	0,17	0,53	0,63	0,47
	SD	0,48	0,32	0,41	0,47	0,49	0,78

Based on the data in Table 1, it is known that the lowest increase in conceptual knowledge in the class with the Jigsaw type cooperative learning model occurred in the dimension of cognitive processes in the category of *analysing* with low basic mathematics ability level. Meanwhile, in the class with conventional learning model, the lowest improvement was found in the cognitive process dimension of *applying* category with high basic mathematics ability level. Furthermore, the average *N-gain* value showed that the highest conceptual knowledge improvement in the Jigsaw-type cooperative learning class was found in the cognitive process dimension of *the understanding* category with a high basic mathematics ability level. In contrast, in the conventional learning class, the highest improvement was found in the dimension of cognitive process of *analysing* category with high basic mathematics ability level.

Based on the data above, it shows that the lowest increase in concept understanding in *Jigsaw* type cooperative learning class is in the dimension of cognitive process of analysing category with low basic mathematics ability level, while in conventional learning class is in the dimension of cognitive process of applying category with high basic mathematics ability level. Furthermore, the average *N-gain* value of concept understanding that obtained the highest increase in concept understanding in the *Jigsaw* type cooperative learning class was in the dimension of cognitive process of understanding category with high basic mathematics ability level, while in the conventional learning class was in the dimension of cognitive process of analysing category with high basic mathematics ability level.

Additional support is seen in the graph of the average percentage N-gain value of students' conceptual knowledge against the basic mathematics ability level based on the application of the learning model, which is shown in Figure 3. The figure 3 shows that each level of basic mathematics ability (low, medium, and high) and the learning model applied have no interaction on the improvement of students' conceptual understanding. Data score results of unianova analysis of the average value of students' conceptual knowledge improvement based on the learning model and the level of basic mathematics ability as a whole. Based on the results of statistical tests after the *n-gain* mean value of students' conceptual knowledge on the dimensions of cognitive processes (understanding, applying, and analysing) is normally distributed and homogeneous. Followed by variant analysis of the average value of the increase in students' conceptual understanding based on the three dimensions of the cognitive process (understanding, applying, and analysing).

Table 2. Results of Two-Way Analysis of Variance (*Anova Two Way*) *n-gain* of Conceptual Knowledge, Learning Model, and Basic Maths Ability

Sources of Diversity	Dimensions of Cognitive Processes								
	Understand			Apply			Analyze		
	df	F-count	*Sig.*	*df*	F-count	*Sig.*	*df*	F-count	*Sig.*
Corrected Model	5	3,07	0,2	5	2,47	0,05	5	0,77	0,58
Intercept	1	208,53	0,00	1	53,84	0,00	1	28,77	0,00
Learning	1	7,15	0,01	1	9,75	0,00	1	0,17	0,68
Basic Math Skills	2	2,98	0,06	2	0,68	0,51	2	0,60	0,55
Learning * Basic Math Skills	2	0,84	0,44	2	0,36	0,70	2	1,05	0,36
Error		0,065			0,122			0,252	

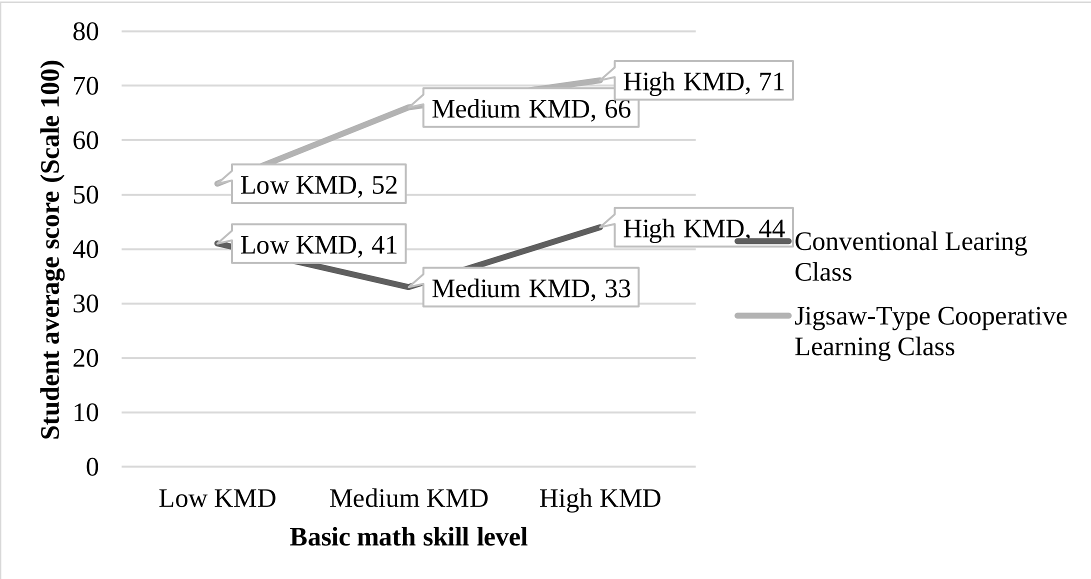

Figure 3 Graph of the average *% n-gain* value of students' conceptual knowledge against the level of students' basic mathematics ability in the application of the learning model.

Table 3. Summary of Analysis of Variance Results of *N-gain* of conceptual knowledge on cognitive process dimensions (understanding, applying, and analysing), Learning Model and basic mathematics ability.

Sources of Diversity	Dimensions of Cognitive Processes								
	Understand			Understand			Understand		
	df	F_{hitung}	*df*	*df*	F_{hitung}	*df*	*df*	F_{hitung}	*df*
Corrected Model	5	3,07	0,2	5	2,47	0,05	5	0,77	0,58
Intercept	1	208,53	0,00	1	53,84	0,00	1	28,77	0,00
Learning	1	7,15	0,01	1	9,75	0,00	1	0,17	0,68
Basic Math Skills	2	2,98	0,06	2	0,68	0,51	2	0,60	0,55
Learning * Basic Math Skills	2	0,84	0,44	2	0,36	0,70	2	1,05	0,36
Error		0,065			0,122			0,252	

There is a significant difference in the learning model on the improvement of students' conceptual knowledge of thermochemistry in the cognitive process dimension of understanding (*Sig. = 0.01*) and applying (*Sig. = 0.00*) categories. Based on the results of the analysis also showed that the level of basic mathematical ability there is no significant difference on the improvement of students' conceptual understanding of thermochemistry in the dimension of cognitive processes category understanding (*Sig. = 0.06*), applying (*Sig. = 0.51*), and analysing (*Sig. = 0.55*). It also showed that the learning model and the level of basic mathematics ability did not have a significant interaction on the improvement of students' conceptual understanding of thermochemistry in the dimensions of the cognitive process of understanding category (*Sig. = 0.44*), applying (*Sig. = 0.70*), and analysing (*Sig. = 0.36*) at the 95% confidence level ($\alpha = 0.05$).

Table 4. Summary of the results of one-way analysis of variance (*Anova One Way*) *N-gain* of students' conceptual knowledge between the dimensions of cognitive processes in each learning model.

	Conventional Learning				**Jigsaw-Type Cooperative Learning Model**			
Dimensions of Cognitive Processes	**Apply**		**Analyze**		**Apply**		**Analyze**	
	t-count	***Sig.***	**t-count**	***Sig.***	**t-count**	***Sig.***	**t-count**	***Sig.***
Understand	0,23*	0,04	0,11	0,34	0,10	0,43	0,22	0,09
Apply	-	-	0,12	0,27	-	-	0,12	0,34

The data in Table 4 also shows that among the three dimensions of cognitive process in the application of cooperative learning model, there is no significant difference on the improvement of students' concept understanding. In other words, the increase in students' understanding of concepts after learning is the same in all dimensions of cognitive processes, namely understanding, applying, and analysing in the application of the *Jigsaw* type cooperative learning model.

Table 5. Summary of results of one-way analysis of variance (*Anova One Way*) *n-gain* of students' conceptual knowledge between basic mathematics ability levels in each learning model.

	Conventional Learning				**Jigsaw-Type Cooperative Learning Model**			
Basic Mathematics Ability	**Moderate**		**High**		**Moderate**		**High**	
	$t_{hit.}$	***Sig.***	**$t_{hit.}$**	***Sig.***	**$t_{hit.}$**	***Sig.***	**$t_{hit.}$**	***Sig.***
Low	0,08	0,29	0,03	0,70	0,14	0,16	0,19	0,08
High	-	-	0,11	0,15	-	-	0,05	0,61

The results of the analysis of variance between the level of basic mathematical ability on the learning model on the improvement of students' conceptual understanding of thermochemical material, namely students who get the *Jigsaw* cooperative learning model, the improvement of students' conceptual understanding between the three levels of basic mathematical ability, namely low, medium, and high there is no significant difference at the 95% confidence level. , for students who received conventional learning, the increase in students' conceptual understanding between the three levels of basic mathematics ability, namely low, medium, and high, there was no significant difference at the 95% confidence level. The increase in students' conceptual knowledge between the cognitive process dimension group of understanding there is a significant difference with the cognitive process dimension of applying in conventional learning class. Table 5. shows that from the three levels of students' basic mathematics ability in the application of *Jigsaw-type* cooperative learning model and conventional learning, there is no significant difference in the improvement of students' conceptual knowledge. In other words, the improvement of students' conceptual knowledge after learning was obtained the same results at all levels of basic mathematics ability, namely low, medium, and high at the application of *Jigsaw* cooperative learning and conventional learning.

Problem Solving Ability Results

The graph of the average value of *pre-test*, *post-test*, and *% n-gain* of students' problem solving ability on Thermochemistry material can be seen in Figure 4. The mean value of the *pre-test* of students' problem solving ability is normally distributed and homogeneous, then the value of $t._{hit} = -0.201$ and $t._{table} = 1.685$ is obtained. Because the value of $t._{(hit)} < t._{tab,}$ then H_0 is accepted so it can be concluded that the average value of the *pre-test* of problem solving ability of experimental class students and control class students is not significantly different. In other words, the two groups of students have the same initial problem solving ability in thermochemistry material.

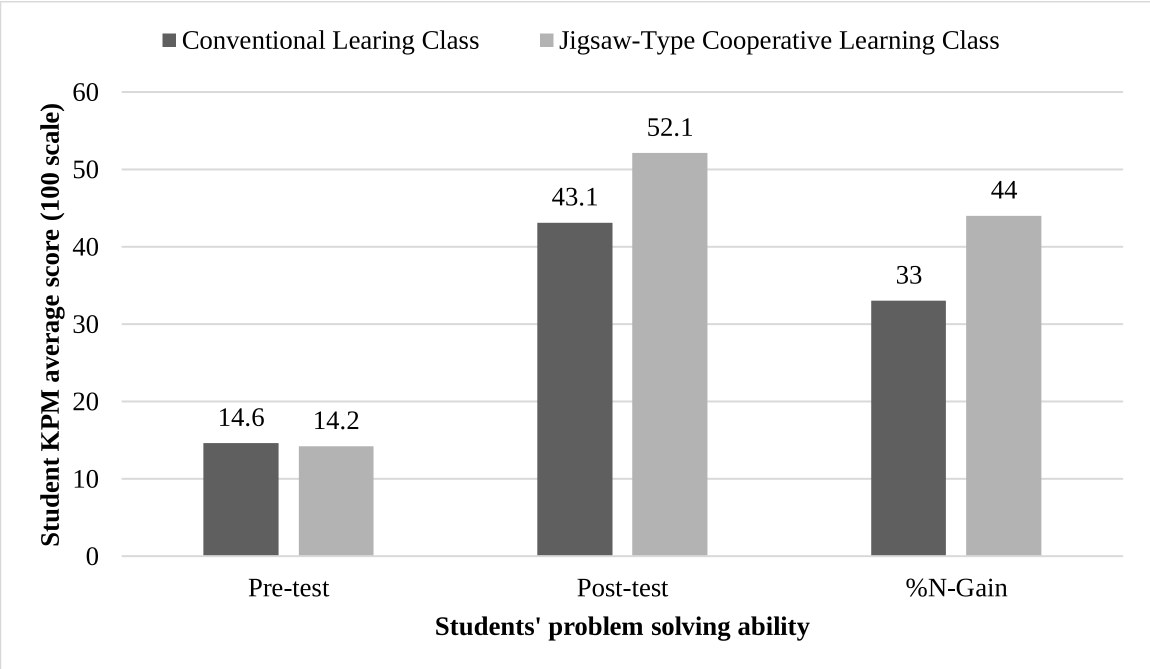

Figure 4. Graph of the average value of *pre-test*, *post-test* and *% n-gain* of problem solving ability in each learning model

The difference in the improvement of problem solving ability between learning models can be explained from the distribution of *N-gain* categories of problem solving ability which shows that the number of students who obtained *N-gain of* problem solving ability in the low and high categories in conventional learning is less than that of the *Jigsaw* type cooperative learning model in the same category. In contrast, the number of students who obtained *N-gain of* problem- solving ability in the medium category in conventional learning is more than in *Jigsaw* cooperative learning model in the same category. This difference indicates that the problem solving ability of high and low ability students is better with the *Jigsaw* cooperative learning model compared to conventional learning. The graph of the average value of *pre-test*, *post-test*, and *% n-gain* of students' problem solving ability based on the level of basic mathematics ability on Thermochemistry material can be seen in Figure 5.

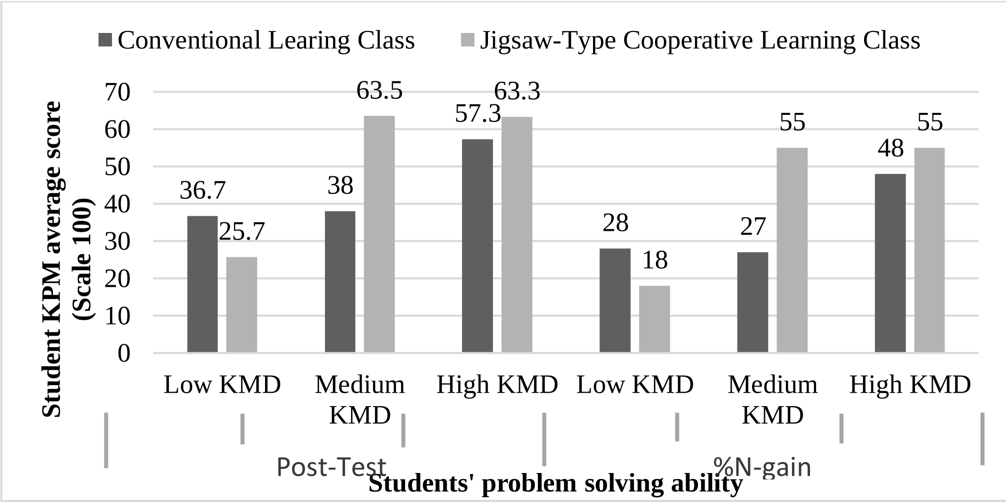

Figure 5. Graph of mean *post-test* score and *% n-gain* of problem solving ability based on basic mathematics ability level and both learning models.

The average *post-test* score of students' problem solving ability at the low basic mathematics ability level, after learning Thermochemistry, for students who received conventional learning model can be considered quantitatively higher than that of students who received *Jigsaw* cooperative learning.

Table 6. *n-gain* description of problem solving ability on four stages/indicators, basic mathematics ability level and learning model

Stages/ Indicators	Problem solving skills	Low Basic Mathematics Ability		Moderate Basic Mathematics Ability		High Basic Mathematics Ability	
		Conv. Learning	Jigsaw-Type Coop. Learning Model	Conv. Learning	Jigsaw-Type Cooperative Learning Model	Conv. Learning	Jigsaw-Type Coop. Learning Model
Understanding the Problem	*Mean*	0,46	0,66	0,00	0,65	0,36	0,33
	SD	0,58	0,41	1,48	0,66	0,56	1,03
Developing a Strategy	*Mean*	0,43	0,14	0,49	0,59	0,61	0,64
	SD	0,29	0,17	0,27	0,40	0,21	0,31
Strategy Completion	*Mean*	0,27	0,08	0,21	0,56	0,53	0,57
	SD	0,15	0,11	0,16	0,30	0,27	0,33
Evaluation	*Mean*	0,00	0,03	0,00	0,39	0,17	0,33
	SD	0,00	0,08	0,00	0,38	0,15	0,37

The data above shows that the average *n-gain* value of problem solving ability that obtained the lowest improvement in the *Jigsaw* cooperative learning class was at the evaluation stage (average = 0.03) with a low level of basic mathematics ability. Meanwhile, in the conventional learning class, it was in the stages of understanding the problem (average= 0.00) and evaluation (average= 0.00) with a low level of basic mathematics ability and the evaluation stage (average = 0.00) with a low basic mathematics ability level. Furthermore, the average *n-gain* value of cooperative learning that obtained the highest improvement in the *Jigsaw* cooperative learning class was in understanding the problem (average = 0.66) with a low basic mathematics ability level. Meanwhile, the conventional learning class was at the stage of developing strategies (average = 0.61) with a high basic mathematics ability level.

Table 7. Results of *Two-way* Analysis of Variance (*Anova Two Way*) *n-gain* of problem solving ability, Learning Model and basic mathematics ability

Sources of Diversity	Sum of Squares	*df*	Mean Square	F_{-count}	*Sig.*
Corrected Model	0,94[a]	5	0,19	3,24	0.02
Intercept	6,03	1	6,03	103,95	0.00
Learning	0,07	1	0,07	1,14	0.29
Basic Math Skills	0,54	2	0,27	4,62	0.02
Learning Basic Math Skills	0,29	2	0,15	2,51	0.10

The average *n-gain* value of problem solving ability of the group of students who have received Jigsaw type cooperative learning has increased which is not significantly different from the n-*gain of* the group of students who received conventional learning. This is based on the *Unianova* test result (Sig. = 0.29) at the 95% confidence level (α = 0.05). Statistical analysis also showed that the improvement of students' problem solving ability in the Jigsaw cooperative learning class was not significantly different from the improvement of students' problem solving ability in the conventional learning class. Thus, the application of Jigsaw cooperative learning is not significantly better in improving students' problem solving ability compared to conventional learning on thermochemistry material. The data also illustrates that the *n-gain* of problem solving ability of student groups with basic mathematics ability level has a significant influence on the increase in the *N-gain* average.

Table 8. Summary of results of t-test analysis of problem solving ability between learning models in terms of basic mathematics ability level

Basic Math Ability Level Pairs Tested	Problem Solving Ability t-Test Results					
	Post-test			*N-Gain*		
	t. count	Sig.	conclusion	t. count	Sig.	conclusion
Low KMD PKJ - Low KMD PKo	-1,287	0,227	Accept H_0 *)	-1,081	0,305	Accept H_0 *)
Moderate KMD PKJ - KMD Moderate PKo	2,612	0,020	Accept H_1 *)	2,258	0,039	Accept H_1 *)
High KMD PKJ - KMD High PKo	0,446	0,665	Accept H_0 *)	0,402	0,696	Accept H_0 *)

The average *post-test* score of problem solving ability of students with moderate basic mathematics ability level in the Jigsaw cooperative learning class is significantly different from that of students in the conventional learning class. In other words, after the learning was conducted, the problem-solving ability of students with low and high basic mathematics ability levels who received learning with the Jigsaw type cooperative learning model was better than the problem-solving ability of students who received conventional learning.

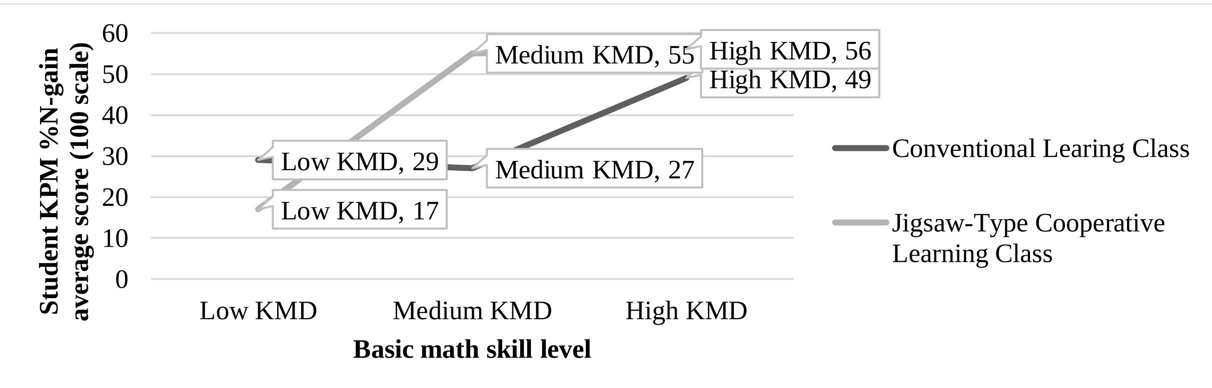

Figure 6. Graph of the average *% n-gain* value of students' problem solving ability against the level of students' basic mathematics ability in the application of the learning model.

The data showed that the level of basic mathematics ability and the learning model applied had no significant interaction on the improvement of students' problem solving ability. This is supported by the graph of the average *% n-gain* value of students' problem solving ability against the level of basic mathematics ability in the application of the learning model, shown in Figure 6. The figure shows that each level of basic mathematics ability (low, medium, and high) and the applied learning model have no interaction on the improvement of students' problem solving ability.

Table 9. Summary of Results of *N-gain* Analysis of variance of problem solving ability based on Stages (understanding the problem, developing strategies, solving strategies, and evaluation), Learning Models and basic mathematics ability

Sources of Diversity	*df*	Stages/ Indicators							
		Understanding the Problem		Developing a Strategy		Strategy Completion		Evaluation	
		F-count	*Sig.*	F-count	*Sig.*	F-count	*Sig.*	F-count	*Sig.*
Corrected Model	5	0,77	0,58	0,88	0,51	0,92	0,48	2,34	0,06
Intercept	1	6,87	0,01	89,8	0,00	62,40	0,00	14,31	0,00
Learning	1	1,73	0,20	0,28	0,60	0,86	0,36	6,63	0,37
Basic Math Skills	2	0,42	0,66	0,45	0,65	0,28	0,76	1,03	0,01
Learning* Basic Math Skills	2	0,84	0,44	1,70	0,20	1,48	0,24	0,97	0,39
Error		0,830		0,102		0,085		0,063	

Based on the results of the Unianova test in Table 9, it shows that at the evaluation stage (*Sig. = 0.01)* there is a significant difference in the improvement of students' thermochemical problem solving skills. Data from the analysis of variance of the average value of the improvement of students' problem solving ability based on the stages in students who received conventional learning, the improvement of students' problem solving ability between the stages of developing strategies is significantly different from the evaluation stage, while between understanding the problem by developing strategies, understanding the problem by solving strategies, understanding the problem by evaluating, developing strategies by solving strategies, and solving strategies by evaluating there is no significant difference at the 95% confidence level.

Table 10. Summary of the results of one-way analysis of variance (*Anova One Way*) *n- gain* of students' problem solving ability between stages/indicators in each learning model.

		Conventional Learning			Jigsaw-Type Cooperative Learning Model		
Stages/ Indicators		Developing a Strategy	Strategy Completion	Evaluaation	Developing a Strategy	Strategy Completion	Evaluaation
Understanding the Problem	T_{cnt}	0,27	0,09	0,19	0,09	0,14	0,29
	Sig.	0,12	0,62	0,27	0,55	0,36	0,06
Developing a Strategy	T_{cnt}	-	0,19	0,46*	-	0,05	0,20
	Sig.	-	0,28	0,01	-	0,75	0,19
Strategy Completion	T_{cnt}	-	-	0,27	-	-	0,15
	Sig.	-	-	0,11	-	-	0,31

The data in Table 10 also showed that for students who received the *Jigsaw* cooperative learning model, the improvement of students' problem solving ability between all stages was not significantly different at the 95% confidence level. In other words, the improvement of students' problem solving ability after learning is the same in all stages, namely understanding the problem, developing strategies, solving strategies and evaluation in the application of the *Jigsaw* type cooperative learning model. In students who received conventional learning, the improvement of students' problem solving ability between the stages of developing strategies was significantly different from the evaluation stage.

Table 11. Summary of results of one-way analysis of variance (*Anova One Way*) *N-gain* of students' problem solving ability between basic mathematics ability levels in each learning model

Basic Math Skills	conceptual knowledge				Jigsaw Cooperative Learning			
	Moderate		High		Moderate		High	
	t-count	*Sig.*	t-count	*Sig.*	t-count	*Sig.*	t-count	*Sig.*
Low	0,02	0,83	0,21	0,07	0,38*	0,03	0,39*	0,03
Moderate	-	-	0,23*	0,03	-	-	0,01	0,98

The data in Table 11 shows that for students who received the *Jigsaw* cooperative learning model, the improvement of students' problem solving ability between the low basic mathematics ability level is significantly different from the medium basic mathematics ability , as well as the improvement of students' problem solving ability between the low basic mathematics ability level is significantly different from the high basic mathematics ability level at the 95% confidence level. The data showed that for students who received conventional learning, the improvement of students' problem solving ability between the moderate basic mathematics ability level was significantly different from the high basic mathematics ability level.

The Jigsaw type cooperative learning model encourages students to be able to find the relationship between the material learned and the situation in real life, meaning that students are required to be able to reveal the relationship between school learning experiences and real life, this is in accordance with the theory of learning constructivism which is the reference in this study. Not only is the material that has been taught functionally meaningful but the material learned will be closely embedded in the student's memory, so it will not be easily forgotten, for conventional learning there is no concretisation of concepts, students only memorise abstract material as a result of *transfer of knowladge* carried out by the teacher. A complete understanding of the material in students who follow direct learning is not achieved or can be achieved but takes a long time. This is what causes the difference in chemical conceptual knowledge between students taught with the *Jigsaw* type cooperative learning model and students taught with the conventional learning model.

Based on the data analysis of students' thermochemical problem solving ability after learning, it shows that the increase in problem solving ability of students who get the *Jigsaw* type cooperative learning model is quantitatively higher than that of students who get conventional learning. This is thought to be due to the *Jigsaw* type cooperative learning that is applied more actively in collaborating to solve the problems given in the LKS. As stated by Slavin (1995), the most important thing in the application of *Jigsaw* cooperative learning is how the process of listening to each other, needing each other, and empathy by giving each student an important role or part in the group. Group members must work together as a solid team to be able to complete the task, and each student has dependence on each other. No student can complete the task without co-operating with their group mates.

Student Responses to the Implementation of the *Jigsaw* Type co-operative Learning Model

Students' response to the Jigsaw-type cooperative learning model is 3.06. This shows that students have a positive attitude towards the Jigsaw-type cooperative learning model, which consists of: 1) feeling happy in Jigsaw-type cooperative learning with an average recapitulation of 3.10; 2) feeling easy to learn in Jigsaw-type cooperative learning with an average recapitulation of 3.03; and 3) feeling motivated in Jigsaw-type cooperative learning with an average recapitulation of 3.06. The *Jigsaw-type* cooperative learning model makes students feel happy in the learning atmosphere and easy to learn so it is very effective for teachers to use to motivate students' learning and focus students' attention on learning.

CONCLUTIONS

Based on the results of data analysis and research hypothesis testing, it can be concluded:

1. The mean *post-test* scores of students' conceptual knowledge in the Jigsaw cooperative learning and conventional learning classes were 72.1 and 51.6, respectively. In terms of students' basic mathematics ability, the mean *post-test* scores of students' conceptual knowledge in the Jigsaw cooperative learning and conventional learning classes with low, medium, and high basic mathematics ability levels were 63.9 and 52.8; 74.0 and 49.1; and 77.8 and 54.2, respectively. For students' problem solving ability, the mean scores in the Jigsaw cooperative learning and conventional learning classes were 52.1 and 43.1, respectively. Based on the level of students' basic mathematics ability grouped into low, medium, and high categories, the average *post-test* scores of students' problem solving ability in the Jigsaw cooperative learning and conventional learning classes were 25.7 and 36.7; 63.5 and 38.0; and 63.3 and 57.3, respectively.
2. The average *N-gain* of students' conceptual knowledge in Jigsaw cooperative learning and conventional learning classes were 0.63 and 0.39, respectively. In terms of students' basic mathematics ability level in the low, medium, and high categories, the average *N-gain* values of students' conceptual knowledge in the Jigsaw cooperative learning and conventional learning classes were 0.52 and 0.41, 0.66 and 0.33, and 0.71 and 0.44, respectively. For students' problem solving ability, the average *N-gain* values in the Jigsaw cooperative learning and conventional learning classes were 0.44 and 0.33, respectively. Based on the level of basic mathematics ability grouped in the low, medium, and high categories, the average *N-gain* value of students' problem solving ability in the Jigsaw cooperative learning and conventional learning classes were 0.18 and 0.28; 0.55 and 0.27; and 0.55 and 0.48, respectively.
3. The group of students who received the Jigsaw cooperative learning model obtained a significantly higher increase in conceptual knowledge compared to the group of students who received conventional learning. However, the increase in students' conceptual knowledge based on basic mathematics ability was not significantly different between students in the Jigsaw cooperative learning model and students in the conventional learning. For students' problem solving ability, the group of students who received the Jigsaw cooperative learning model obtained an increase in problem solving ability that was not significantly different from the group of students who received conventional learning on Thermochemistry material. Meanwhile, the improvement of problem solving ability of students with moderate basic mathematics ability level who received the Jigsaw cooperative learning model was significantly higher than that of students who received conventional learning, while for low and high levels of basic mathematics ability, there was no significant difference.
4. The level of students' basic mathematics ability does not significantly affect the improvement of students' conceptual knowledge in Thermochemistry. This shows that although students have different basic mathematics abilities, there is no significant difference in improving the understanding of the concepts taught in the material. However, the level of students' basic mathematics ability is proven to have an effect on the improvement of students' problem solving skills in Thermochemistry. Students with

higher levels of basic maths ability tended to show better improvement in problem solving ability, compared to students with lower levels of basic maths ability. This suggests that basic maths ability can influence the extent to which students can apply the concepts learnt in solving problems related to Thermochemistry.

5. There is no interaction between the level of basic mathematics ability and the learning model on the improvement of students' conceptual knowledge and problem solving skills in thermochemistry.
6. Students' responses to the *Jigsaw* type cooperative learning model showed that they were happy, easy, and they were motivated in learning.
7. Teacher's response to the *Jigsaw* cooperative learning model acting as a facilitator to provide guidance during group activities can improve and enhance the quality of chemistry learning in the classroom and overcome the problem of students' inactivity in chemistry lessons.
8. The researcher's further response is that it can provide knowledge about the importance of choosing a teaching model in a learning environment and provide experience from a teaching that has been carried out.

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