Jurnal Pendidikan Kimia Indonesia
Volume 8, Issue 2, 2024, pp. 75-86
p-ISSN: 2087-9040 e-ISSN: 2613-9537
Open Access: https://doi.org/10.23887/jpki.v8i2.76461

The Effect of STAD-Cooperative Learning Model with Concept Maps in Promoting Students' Self-Efficacy and Conceptual Understanding of Thermochemistry

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ARTICLE INFO

Article history:
Received March 20, 2024
Revised July 1, 2024
Accepted October 15, 2024
Available online November 14, 2024

Kata Kunci:
STAD, Peta Konsep, Pemahaman Konsptual, Efikasi Diri, Termokimia

Keywords:
STAD, Concept Maps, Conceptual Understanding, Self-Efficacy, Thermochemistry

ABSTRAK

Penelitian ini bertujuan untuk menyelidiki bagaimana penggunaan model pembelajaran kooperatif Student Team Achievement Division (STAD) yang dikombinasikan dengan peta konsep mempengaruhi efikasi diri dan pemahaman konsep termokimia siswa. Studi ini menggunakan pendekatan quasi-eksperimental dengan desain kelompok kontrol pretest-posttest. Penelitian ini dilakukan pada 127 siswa kelas 11 IPA dari MAN 1 Kota Bengkulu, yang dipilih melalui teknik cluster random sampling. Informasi dikumpulkan dengan menggunakan kuesioner efikasi diri dan tes pemahaman konseptual, dan dianalisis menggunakan Analisis Varian Multivariat (MANOVA). Hasil penelitian menunjukkan bahwa nilai p yang diperoleh kurang dari 0,05, menunjukkan perbedaan yang signifikan pada efikasi diri dan pemahaman konseptual antara kedua kelompok. Selain itu, siswa dalam kelompok eksperiment menunjukkan peningkatan yang lebih besar pada efikasi diri dan pemahaman konseptual dibandingkan dengan siswa dalam kelompok kontrol. Oleh karena itu, hasil penelitian ini mengungkapkan bahwa pembelajaran kooperatif STAD dengan peta konsep memiliki pengaruh yang lebih baik dalam meningkatkan efikasi diri dan pemahaman konsep termokimia siswa.

ABSTRACT

The research sought to explore how employing the Student Team Achievement Division (STAD) cooperative learning model, along with concept maps, impacts the enhancement of students' self-efficacy and grasp of thermochemistry concepts. This study employed a quasi-experimental approach using a pretest-posttest control group design. It was carried out among 127 11th-grade science students from MAN 1 Bengkulu City, chosen through cluster random sampling. The information was gathered by utilizing self-efficacy questionnaires and conceptual understanding tests and was analyzed using Multivariate Analysis of Variance (MANOVA). The findings indicated that the obtained p-value was less than 0.05 ($p<0.05$), revealing a statistically significant difference in self-efficacy and conceptual understanding between students in the experimental and control groups. This suggests that students in the experimental group showed greater enhancements in self-efficacy and conceptual understanding when compared to those in the controlled group. Thus, These findings revealed that STAD-cooperative learning with concept maps had a better influence in enhancing self-efficacy and student conceptual understanding of thermochemistry.

1. INTRODUCTION

The various instructional strategies that can offer a positive impact on enhancing students' comprehension of chemistry are still being investigated. It is based on the perception among students who assume chemistry is a challenging subject because it encompasses a wide range of complex principles and abstract concepts that demand deep understanding by students (Khairani et al., 2022; Turan Oluk & Ekmekci, 2016). Chemistry is considered highly conceptual compared to other fields and needs complex relationships between concepts, making it difficult for students to understand. Additionally, chemistry has its own language and is inherently symbolic, requiring a strong capacity for abstraction and generalization to understand it. As a result, teaching and learning chemistry is indeed a complex task (Mossi & Júnior, 2022; Okumuş et al., 2019; Sing, 2015).

The application of scientific learning methods aimed to reduce student difficulties has not significantly improved students' understanding of chemistry. Many students still express negative feelings

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towards chemistry lessons, often attributing their struggles to a lack of understanding of fundamental concepts and difficulty in completing chemistry tasks (Cetin-Dindar & Geban, 2017). Following the interview with the chemistry teacher at MAN 1 Bengkulu City, it was revealed that the evaluation results for the 11th science class in chemistry were below the standard of minimum completeness. This was particularly evident in the learning results of students on the topic of thermochemistry, with the average score falling below the minimum passing grade of 75. In contrast, the average score of students in other chemistry evaluations has already reached or even exceeded the standard of minimum completeness. The root cause of the low evaluation results in thermochemistry can be attributed to the complexity of the subject matter that requires deep understanding from the students themselves. There are numerous concepts that students need to understand, and students also have to ideate the relation between these concepts. Furthermore, the lack of student understanding of basic thermochemistry concepts, such as the ability to distinguish between systems and environments, and the characteristics of exothermic and endothermic reactions, also contributes to the poor learning outcomes of thermochemistry (Purnomo et al., 2022; Wibowo & Subagiyo, 2022; Aldwinarta et al., 2024).

Conceptual understanding can not be underestimated in constructing a cognitive framework because conceptual understanding has a close link with the improvement of students' cognitive ability. A student can optimize the growth of their cognitive framework if their conceptual understanding of the subject matter is already good (Suarsana et al., 2018). Conceptual understanding entails building extensive and profound knowledge, as well as the capacity to comprehend and establish connections between ideas and concepts and apply this understanding in various contexts (Alao & Guthrie, 1999). Akkuzu and Uyulgan (2016) argue that understanding a concept goes beyond merely knowing its definition or explanation; it also involves comprehending the connections between concepts and their development in the minds of students.

Inadequate understanding of chemistry concepts can erode students' confidence in their learning abilities. As a result, they may feel uncertain about their capacity to answer questions or complete assignments, leading to a decline in their self-efficacy. According to Albert Bandura's social cognitive theory, introduced in 1986, self-efficacy is the confidence individuals have in their capacity to set goals and take the necessary steps to achieve them (Mataka & Kowalske, 2015). In the context of learning, self-efficacy plays a vital role in shaping students' academic success. Students who believe in their ability to learn and succeed tend to excel academically, whereas those who doubt their capabilities often struggle to achieve their full potential (Bressington et al., 2018). Therefore, it is essential to implement teaching strategies in chemistry that foster the growth of self-efficacy and enhance students' conceptual understanding of the subject matter.

In recent years, researchers have been making an effort to find better and more innovative strategies to improve meaningful learning of chemistry (Aguiar & Correia, 2016). Meaningful learning refers to the formation of proper correlations between ideas, concepts, and information in a person's mind (Sing, 2015). Meaningful learning in chemistry enables students to fully grasp fundamental concepts, which in turn allows them to apply their knowledge to resolve problems in new conditions (Ghani et al., 2017). Meaningful learning can be attained through the combination of well-designed instructional materials with student involvement in the process of developing an understanding from what is being learned by students (Aguiar & Correia, 2016). One effective method to enhance meaningful learning in the field of chemistry is by incorporating concept maps into the learning process (Nopiani et al., 2017). Concept maps are helpful educational tools for students. They assist in organizing and visualizing information and are effective for illustrating connections, relationships, and hierarchies between different concepts in chemistry. This subject covers a wide range of topics, theories, laws, facts, and hypotheses that require a strong understanding of inter-concept relationships (Burrows & Mooring, 2015; Tella & Ogundiya, 2022; Turan-Oluk & Ekmekci, 2018).

In 1984, Novak introduced concept maps based on meaningful learning theory and cognitive assimilation theory by Ausubel. A concept map comprises concept terms, connecting arrows, and linking phrases. The connecting arrows represent the relationship or direction between two concepts, while the linking phrases describe the relationship between the concepts (Chen et al., 2019; Turan-Oluk & Ekmekci, 2018). As Chiou et al. (2017) outlined, there are three methods for creating concept maps: the paper-and-pencil approach (PAP), the computer-assisted construct-by-self approach (CACBS), and the computer-assisted construct-on-scaffold approach (CACOS).

Concept maps can be an effective cognitive tool that visually illustrates knowledge. They are effective for measuring the deepness and broadness of a student's understanding, as well as facilitating meaningful learning (Burrows & Mooring, 2015; Wang et al., 2017; Chen et al., 2019; Tella & Ogundiya, 2022). Numerous investigations have demonstrated that using concept maps during learning greatly enhances the deep understanding of subject materials and has positive impacts on the attitude, motivation, and learning outcomes of students, regardless of the type of concept map utilized. However a counterintuitive phenomenon has emerged: despite these cognitive and affective gains, students' confidence in their abilities tends to wane following the completion of their concept maps. (Bressington et al., 2018; Y. T. Lin et al., 2016). Integrating concept maps with cooperative learning models can be more beneficial in enhancing students' learning outcomes (Zakiyatun et al., 2017). This is because a cooperative learning model with concept maps is an effective teaching strategy. Nevertheless, studies that integrate concept maps into cooperative learning are scarce (Silva et al., 2022).

Cooperative learning is a constructivist-based teaching method and centers on students that foster active student roles to engage and communicate during the learning activity (Apugliese & Lewis, 2017). There are five common models of cooperative learning, including Student-Teams Achievement Divisions (STAD), Cooperative Integrated Reading and Composition (CIRC), Teams-Games-Tournament (TGT), Team-Assisted Individualization (TAI), and JIGSAW (Slavin, 2015). One effective cooperative learning model for integrating concept map construction into the teaching process is the Student-Teams Achievement Division (STAD). STAD is a straightforward and efficient method for implementing cooperative learning. In this model, students are placed into several learning groups, each composed of four or five diverse members. The STAD learning model promotes active engagement among students as they understand and discuss various concepts with their group members (Slavin, 2015; Simamora, 2017). STAD-cooperative learning model consists of five steps: 1) classroom presentation, 2) group organization, 3) quiz, 4) individual score achievement (individual improvement scores), and 5) group reward (team recognition) (Slavin, 2015). Research by Kırık and Boz (2012) highlights the potential of STAD cooperative learning to enhance students' grasp of chemical kinetics and boost their enthusiasm for the chemistry course. By fostering a collaborative learning environment, this approach can also promote increased self-confidence in students' learning abilities. Furthermore, other research findings state that STAD cooperative learning yields more effective learning outcomes compared to other cooperative learning models (Ozdilek et al., 2018).

In addition, other research findings claimed that involving concept mapping activity in STAD learning can empower students to cooperate with their peers, thereby enhancing their ability to express different ideas and potentially increasing students' creative thinking skills (Irawan et al., 2021). This study seeks to uncover the effect of the STAD cooperative learning model, supplemented by concept mapping, on students' self-efficacy and conceptual understanding of thermochemistry. It is expected that the STAD cooperative learning model, combined with concept mapping, will boost in students' ability to navigate complex chemical concepts and develop a more resilient sense of self-efficacy.

2. METHOD

The study employed a quantitative methodology and a quasi-experimental design featuring a pretest-posttest control group. This design necessitates a division into an experimental group and a control group (Malmia et al., 2019). The research took place at MAN 1 Bengkulu City between September and October 2023, involving a total of five 11th-grade science classes. The research sample was chosen using a cluster random sampling technique, where groups of participants were randomly selected from a larger population. This approach allowed us to focus on a subset of students, which became the core of our study. Notably, the success of cluster random sampling relies on the assumption that all groups within the larger population share similar characteristics (Baltes & Ralph, 2022; Stratton, 2019). In this study, 127 students from four 11th-grade science classes at MAN 1 Bengkulu City were randomly selected to be part of the experiment and control groups. This selection was made after the ANOVA test results showed no significant differences in the midterm exam scores of students from five 11^{th}-grade science classes. Both groups were initially given a pre-test with the same questions. Next, the experimental group implemented the STAD-cooperative learning model with concept maps, while the control group conducted scientific learning in as many as four meetings. Finally, both experimental and control groups were conducted post-test with the same questions as the final step in this research.

In the research, two data collection tools were used to investigate how the cooperative learning method STAD with concept maps affects students' self-efficacy and understanding of thermochemistry. These tools were a conceptual understanding test and a self-efficacy questionnaire. The researcher designed a conceptual understanding test with 20 multiple-choice questions to assess students' comprehension of thermochemistry, using content outlines and conceptual understanding indicators. The indicators of conceptual understanding test were synthesized from the definition of conceptual understanding according to Bowen and Bunce (1997), Alao and Guthrie (1999), Holme et al. (2015), Akkuzu and Uyulgan (2016), and Aydin Ceran and Ates (2020). The self-efficacy questionnaire consists of 30 statements, both on the pretest and posttest and uses a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The self-efficacy questionnaire was designed by the researcher based on the results of a synthesis of definitions of self-efficacy by Bandura (1977), Schunk (1995), Ferell and Barbera (2015), and Baanu et al. (2016) as well as the development of a self-efficacy questionnaire by Lin et al. (2013). Those data collection instruments were used in this research after each item from both instruments was ensured valid and reliable. The validity and reliability of two data collection tools were assessed using the Quest program. The data collection tool items are deemed valid if they have an Infit Mean Square (Infit MNSQ) value consistent with the Rasch Model, falling between 0.77 and 1.30 (Subali & Suyata, 2012). The reliability of data collection tools is assessed by reviewing the item estimate and case estimate reliability in the output of the Quest program. A higher Reliability of Item estimate increases the number of items that match the passing items (fit) (Hanna & Retnawati, 2022). The results of the validity of both data collection tools showed consistency with the Rasch model, with infit MNSQ values ranging between 0.77 to 1.30, and the reliability of those instruments falls within the good and very good categories. Table 1 presents Infit MNSQ and reliability item values of data collection tools.

Table 1. The Infit MNSQ and Reliability Item Values

Validity Test		Reliability Test	
Instruments	**Infit MNSQ values**	**Reliability values**	**Category**
Self-efficacy	0.78-1.22	0.82	Good
Conceptual Understanding (pretest)	0.86-1.14	0.91	Very Good
Conceptual Understanding (posttest)	0.9 – 1.10	0.88	Good

The teaching procedure applied in the experimental class follows the cooperative learning steps of STAD. The learning starts with students distributed into heterogeneous groups covering five to six members. The teacher then explains the material by emphasizing students on the activities provided in the Student Worksheet (SW). Student worksheet is prepared for the experimental group and contains activities consistent with the STAD learning steps. All students are requested to cooperate with their members to complete the activities in the SW, especially the group organization activities. The group organization activities ask students to construct a concept map from the concept lists provided in the SW. Before students create their concept map, the teacher explains how to construct one and provides an example with incomplete parts, as shown in Figure 1. The concept map is created using a computer-assisted construct-on-scaffold approach. This requires students to complete the blank parts of the concept that have not been filled in by the expert (Chiou et al., 2017). Students then fill in the concept map during the quiz activity by choosing the correct words from the given answer lists. After the quiz, each group calculates the total score gained from their members' scores and the teacher awards recognition to the group with the highest score. In the control group, students engaged in learning activities based on scientific instruction. These activities involved observing, questioning, gathering information, making connections, and communicating.

The pretest-posttest data for both the experimental and control groups was analyzed using quantitative methods to assess self-efficacy and conceptual understanding. This analysis included descriptive statistical analysis, N-Gain score determination, Multivariate Analysis of Variance (MANOVA), and effect size measurement. The N-Gain score is calculated by subtracting the pretest scores from the posttest scores for each student, measuring both self-efficacy and conceptual understanding. The N-Gain score criteria can be established based on the N-Gain score achieved, as outlined in Table 2 (Hake, 1999). The calculation of the N-Gain score can be accomplished using the following formulation.

$$N - gain = \frac{(S\,postest - S\,pretest)}{(S\,maximum - S\,pretest)} \quad (1)$$

Table 2. The Criteria of N-Gain score

Score	Category
N-gain> 0.7	High
0.3 =N-gain= 0.7	Medium
N-gain< 0.3	Low

MANOVA is an extension of ANOVA (Analysis of Variance) that has better capability than ANOVA to analyze interactions between two factors or variables. In a MANOVA test, two or more dependent measures are entered into the same statistical analysis, whereas ANOVA is limited to only one dependent variable (Emerson, 2018; Okonofua et al., 2020). Before conducting the MANOVA test, a preliminary test is performed to check that all MANOVA assumptions are met. These assumptions include univariate and multivariate outliers, multivariate normal distribution, homogeneity of variance-covariance matrices between groups, linear relationship between covariates and dependent variables, absence of multicollinearity, and homogeneity of variances of dependent variables (Nyet et al., 2017). The effect size measurement was purposed to define the contribution of the STAD-cooperative learning model with concept maps toward students' self-efficacy and conceptual understanding. The effect size can be derived from the partial eta squared value in the SPSS output, and then multiplied by 100 percent. The guidelines for effect size are outlined in Table 3 (Thahir et al., 2020).

Table 3. The Criteria of Effect Size

Score	Category
$\eta^2_{partial} < 0.2$	Low
$0.2 < \eta^2_{partial} < 0.8$	Medium
$\eta^2_{partial} > 0.8$	High

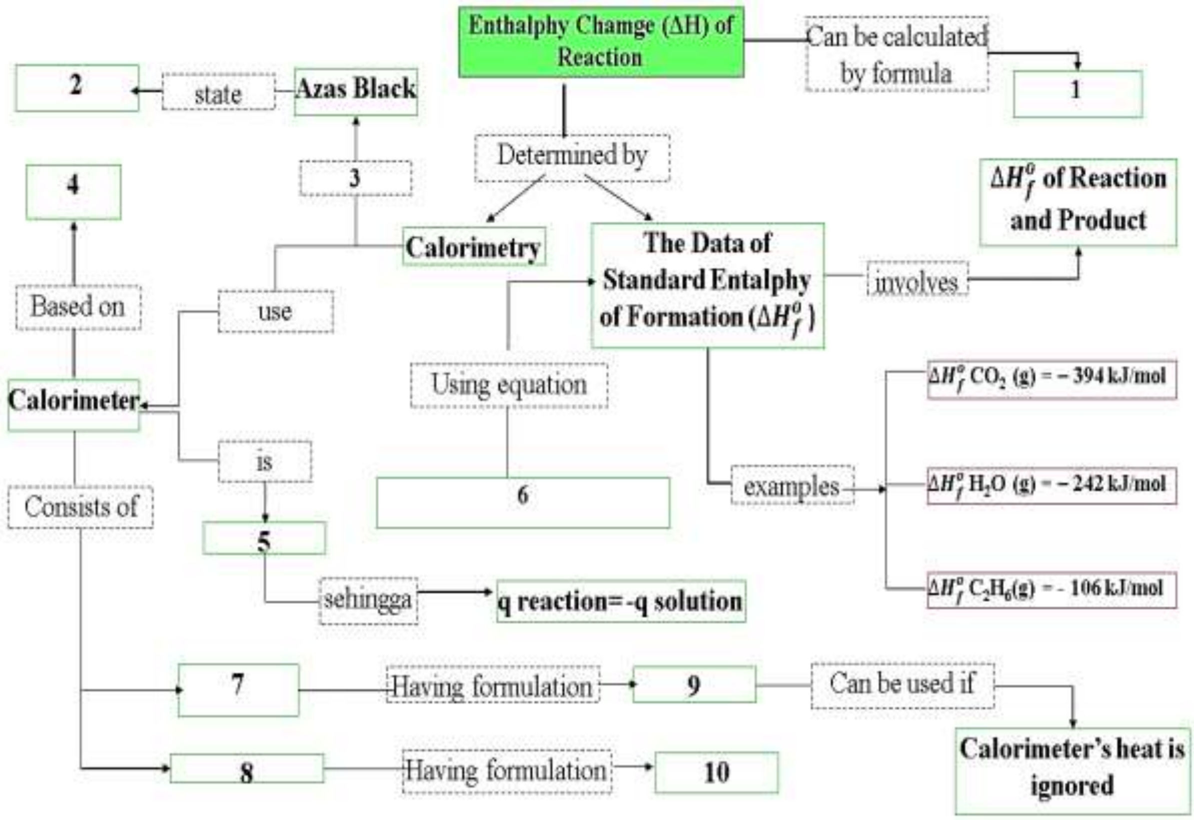

Figure 1. Concept maps created by the researcher

3. RESULT AND DISCUSSION

Result

Descriptive statistical analysis presents the achievement of self-efficacy and students' conceptual understanding between the experimental and control groups. The outcomes are summarized in Table 4.

Table 4. The Results of Descriptive Statistical Analysis

Dependent Variable	Groups	N	Pretest		Posttest	
			Mean	Standard Deviation	Mean	Standard Deviation
Self-Efficacy	Experiment	67	52.32	5.63	72.68	5.95
	Control	60	56.99	5.89	67.18	7.05
Conceptual Understanding	Experiment	67	24.27	10.93	71.34	12.81
	Control	60	24.90	9.66	60.75	11.23

Based on the descriptive analysis results shown in Table 4, both the experimental and control groups exhibited improvements in self-efficacy, as indicated by the differences in the result calculatiom of mean scores between the post-test and pretest results. Nevertheless, the control group exhibited a smaller increase compared to the experimental group. In the pretest, the control group had a mean score of 56.99, which was higher than the mean score of the experimental group. In the posttest, the mean value of the experimental group was 72.68, while the control group's mean score was 67.18. The research findings suggested that the experimental group exhibited a substantially greater improvement in self-efficacy relative to the control group. Moreover, a significant difference was observed in the average scores for conceptual understanding before and after the study in both groups. Despite the control group having a higher mean score of 24.90 prior to the study, the experimental group attained a more increased mean score of 71.34 after the study. The experimental group experienced an enhancement of 47.13, while the control group saw an increase of 35.92. This indicates that the experimental group demonstrated better improvement in students' conceptual understanding relative to the control group. According to the descriptive statistical analysis, it seems that students in the experimental group achieved more increased levels of self-efficacy and conceptual understanding than the control group.

Improvement in self-efficacy and conceptual understanding among students in both the experimental and control groups is also evident from the average N-Gain scores calculated. N-Gain scores indicate the extent of improvement in self-efficacy and conceptual understanding. The N-Gain score calculation results can be found in Table 5.

Table 5. The averages of N-Gain scores

Groups	The Averages of N-Gain Scores			
	Self-Efficacy	**Category**	**Conceptual Understanding**	**Category**
Control	0.24	Low	0.48	Medium
Experiment	0.42	Medium	0.62	Medium

As pictured in Table 5, these indicate that students who participated in the cooperative learning model (experimental group) demonstrated greater gains in both self-efficacy and conceptual understanding compared to their peers in the scientific learning environment (control group). The N-Gain score averages for self-efficacy and conceptual understanding of students in the experimental group are 0.42 and 0.62, respectively, and the control group achieved N-Gain scores averages for self-efficacy and conceptual understanding of 0.24 and 0.48, respectively. Based on the N-Gain scores categories, the conceptual understanding of students in both groups get into the same category, which is the "medium" category, but both groups differ in the self-efficacy category obtained, where the experimental group received the "medium" level, while the controlled group received the "low" category. The comparison of Ngain Scores averages can also be seen in Figure 2.

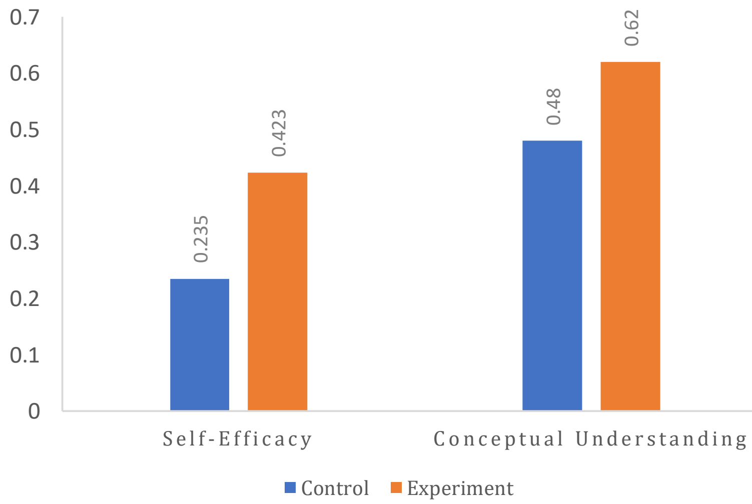

Figure 2. Comparison of the N-Gain scores averages between the experimental and control groups

Figure 2 illustrates that students who engaged in the cooperative learning model experienced a greater increase in self-efficacy and conceptual understanding compared to their peers in the scientific learning environment (control group), based on the average N-Gain scores. The analysis of N-Gain scores led to the conclusion that the implementation of the STAD-cooperative learning model supported by concept maps in the experimental group facilitated improved development of self-efficacy and student conceptual understanding of thermochemistry.

An analysis to examine the significant difference difference between the two groups in this study in terms of self-efficacy and conceptual understanding score achievements was carried out using the MANOVA test. A MANOVA analysis was executed on the N-Gain scores obtained from students in two groups in the study after the preliminary MANOVA test ensured all MANOVA assumptions were already met. The results of the MANOVA are summarized in Table 6.

Table 6. The Results of MANOVA Test

Effect	Test Name	P	*Partial η²*
Groups	*Hottelling's Trace*	0.000	0.337

From Table 6, Hottelling's Trace statistic is used in concurrence with the MANOVA to determine the significance of both groups. The results of the MANOVA analysis, as presented in Table 6, the MANOVA analysis showed a significant difference in self-efficacy and conceptual understanding attainment scores among the groups ($p < 0.05$; $\eta 2 = 0.337$). The second MANOVA test results were conducted to investigate the significance of each dependent variable between the groups. The second MANOVA test results are presented in Table 7.

Table 7. Test of Between Subject Results

Variables	Mean Square	p	*Partial η²*
Self-efficacy	1.049	0.000	0.336
Conceptual understanding	0.554	0.000	0.158

The results from Table 7 indicated that the variables of self-efficacy and conceptual understanding were highly significant ($p<0.05$). The findings demonstrated a statistically noteworthy variation in the average N-Gain scores for self-efficacy and conceptual understanding among students who utilized STAD-cooperative learning with concept maps compared to those who were taught using scientific learning instruction. Additionally, the partial eta squared values for the two variables are 0.336 and 0.158. It indicated that the teaching techniques utilized had a notable impact on students' self-efficacy and conceptual understanding. To assess the impact of the teaching method on the dependent variables, the partial eta-squared values for each dependent variable were utilized to determine the effect size. The findings from this assessment are available in Table 8.

Table 8. The Results of effect size measurements

Variables	*Partial Eta Squared*	Category	Percentage of Effect Size
Self-efficacy	0.158	Low	15.8 %
Conceptual understanding	0.336	Moderate	33.6 %

Based on the table, it is apparent that the self-efficacy effect size percentage is 33.6, while the conceptual understanding effect size percentage is 15.8. These percentages indicated that the teaching methods had a moderate impact on self-efficacy and a lower effect on conceptual understanding. In other words, these findings indicate that the STAD-cooperative model learning with concept maps moderately influenced students' self-efficacy and had a less significant impact on their conceptual understanding.

Discussion

The STAD-cooperative learning model supported with concept maps has been implemented in this study to enhance students' self-efficacy and conceptual understanding. Based on the research conducted, the STAD-cooperative learning model offered opportunities for students to work together to understand the material during the learning process. Ari & Sadi (2019) exhibited that STAD learning causes a sense of pride in students when they are involved in their group's success and are appreciated by teachers, which is a crucial factor in enhancing students' self-efficacy. STAD model also exhibited a more comprehensive understanding of the subject matter through discussions and learning groups in the learning process (Simamora, 2017). Additionally, the benefit of concept maps in STAD learning activity promotes students to understand the material independently because the activity of constructing concept maps facilitates a more effective learning process. Moore et al. (2015) explained that student involvement in creating concept maps encourages the ability to explore and review topics that are relevant to the already understood concepts and the more detailed information summarizing process. Concept maps also stimulate student engagement in the learning process to solidify their conceptual understanding.

The use of concept mapping during the STAD learning activity positively affected student self-efficacy. This was evident from the results of the statistical analysis and the N-Gain scores. The research showed a significant difference in the self-efficacy achievement and conceptual understanding of thermochemistry between students who participated in the experimental group and those who used a scientific learning strategy. The experimental group, which used cooperative learning STAD with concept maps, displayed a higher increase in self-efficacy compared to the control group, indicating a greater confidence in task completion. Therefore, the STAD-cooperative learning model with concept maps was effective in enhancing students' self-efficacy and conceptual understanding. Gencosman and Doğru (2012) mentioned that the STAD learning models had a very high impact on student self-efficacy compared to traditional teaching methods. The cooperative learning method can improve student learning because the

STAD activities help students stay motivated and take responsibility during the learning journey. Additionally, the function of interactive concept maps in the learning process was believed to be a valuable learning tool with a good impact on the progress of self-efficacy and the improvement of student understanding (Simamora, 2017; Kusumadewi & Kusmaryono, 2022; Rugh et al., 2023) . Consequently, it concluded that the cooperative learning of STAD supported by concept maps positively affected the students' self-efficacy during learning, especially when students contributed to a group to create concept maps. The active attitude of students during group work will provide them with high self-confidence in expressing ideas and insights from what students know and understand (Ari & Sadi, 2019; Gencosman & Doğru, 2012).

On the other hand, another research finding claimed that the students' self-efficacy improved better in collaborative learning with computerized concept maps or collaborative concept maps (Chu et al., 2014), but it is different according to Bressington et al. (2018) who revealed that the students' self-efficacy decreased after they completed the concept map. The findings of this research evaluate that students' difficulty in actively participating in each stage of STAD learning, particularly when answering quizzes and constructing concept maps during the learning process, is responsible for the low self-efficacy in students. The decrease in students' self-efficacy in STAD learning can occur when students tend to ignore their responsibilities as group members and do not contribute to the team's development score. The STAD learning model creates a sense of pride in students if they play an important role in the group's success (Ari & Sadi, 2019). This feeling of accomplishment significantly affects their self-confidence, which is the most vital indicator in students' self-efficacy development. Therefore, students who actively contribute to their group, whether in answering quizzes or constructing concept maps, showed high self-efficacy.

The results also reveal that the STAD learning model with concept maps significantly affected the conceptual understanding of students. Based on these research findings, the conceptual understanding of students who were taught with the STAD teaching method with concept maps achieved higher results than students who followed scientific teaching methods. However, the findings in this research contradict some of the previous study results that also used the STAD-cooperative learning model. The previous study reported that the learning activities of STAD did not yield a significant influence on students' conceptual understanding, as STAD produced lower learning gains in students' understanding of biology concepts (Prayitno et al., 2022), whereas Okumuş et al. (2020) revealed that the group receiving the STAD-cooperative learning model was the most successful, and STAD learning was effective in the conceptual understanding of equilibrium reaction. The STAD learning model that engages students in the group organization activity in constructing concept maps was seen as a significant factor in increasing the students' conceptual understanding in this study. By working together to create a concept map, students can share their understanding and build on each other's ideas, generating a more comprehensive and accurate understanding of the material. Based on the concept map created by the students and their explanations on the functional worksheet, it appears that the students have successfully identified the characteristics of exothermic and endothermic reactions, written the reaction of standard enthalpy for formation, decomposition, and combustion, and explained the concept of determining the ΔH reaction value.

The results of this study align with Kusuma and Busyairi's (2023) research, which involved using concept maps in the STAD teaching approach. It was discovered that the Reading Concept Mapping-Student Team Achievement Division (Remap-STAD) model greatly influenced students' metacognitive abilities and cognitive learning achievements. Concept maps were effective in aiding students to organize and structure their knowledge in promoting a deeper understanding of each concept. Moreover, the further use of concept mapping in STAD learning model facilitated students to explore their knowledge related to a particular concept and to identify relationships between new concepts and ones they have already understood. Thus, The involvement of concept maps in the STAD-cooperative learning helped students to analyze concepts and to utilize their knowledge in the evaluation of their learning (Kusuma & Busyairi, 2023; Moore et al., 2015). Other research findings described that using concept maps in the learning strategy has the ability to improve students' performance in mol concepts and leads to a significant impact on achievement in chemistry subjects (Chawla, 2015; Damaso & Banda, 2019). The concept maps are said to be as a tool to enhance students' understanding because they have a close relationship with meaningful learning (Kusumadewi & Kusmaryono, 2022). Accordingly, this study state that involving concept maps in the STAD-cooperative learning models provided a beneficial impact on developing students' conceptual understanding of thermochemistry.

4. CONCLUSION

The study aims to investigate the impact of the STAD-cooperative learning model with concept maps on the self-efficacy and conceptual understanding of thermochemistry students. The findings showed that incorporating cooperative learning STAD along with concept maps significantly improved students' self-efficacy and conceptual understanding. As a result, students in the experimental group demonstrated greater enhancements in self-efficacy and conceptual understanding compared to those in the control group. In conclusion, it can be inferred that employing cooperative learning STAD with concept maps has a positive effect on the improvement of self-efficacy and conceptual understanding among chemistry students.

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