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Mind Mapping Meets Classical Music: An Effective Strategy to Improve Chemistry Learning Achievement in Hydrocarbon Topic

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ABSTRACT

Purpose of the study: The purpose of this study is to evaluate the influence of using mind mapping learning accompanied by classical music on chemistry learning outcomes in the topic of hydrocarbon compounds among Class X students at State Senior High School 1 Tapung, Kampar.

Methodology: This research uses an experimental method with a t-test design, where Class X-3 serves as the control group following conventional learning (teacher-centered), and Class X-5 serves as the experimental group using mind mapping learning accompanied by classical music. The data collection instruments consist of pre-test and post-test questions.

Main Findings: The results of the descriptive analysis show that the experimental class, which used mind mapping accompanied by classical music, achieved higher learning outcomes compared to the control class that followed conventional learning methods. The results of the inferential analysis, using homogeneity and normality tests, indicate that the study hypothesis is accepted, showing a significant difference in student learning outcomes between the two groups. The t-test results reveal that tcount > ttable (3.43 > 1.61), with an effect size of 14%. The use of mind mapping learning accompanied by classical music significantly improves student learning outcomes on the topic of hydrocarbon compounds compared to conventional learning methods.

Novelty/Originality of this study: This study provides a new contribution by proving that the use of mind mapping learning models combined with classical music can significantly improve student learning outcomes on hydrocarbon compound material compared to conventional learning.

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1. INTRODUCTION

Chemistry is the science that studies matter, natural phenomena, and the mechanisms that occur within them [1]. More simply put, chemistry is closely related to our daily lives [2]-[4]. Everything we experience, from what we see in nature, what we do, to why matter behaves the way it does, is connected to chemistry. Therefore, teaching chemistry should start with the students' own lives. From the moment they wake up in the morning, throughout their daily activities, at school, and even when they return to sleep in the evening, everything is related to chemistry and science in general. Mind mapping is an effective learning model for teaching chemistry, as it is a note-taking method that helps students study more easily [5]-[7]. This learning method allows students to start with the central topic and then move outward (left-right, top-bottom) based on their needs [8]-[10]. It aids memory retention because it aligns with how the brain works [11]-[13].

Especially if students use different colors for each main branch in their mind maps, the process becomes more engaging. Besides making the mind map visually appealing, this approach also makes studying more exciting [14]-[16]. The use of colors can attract students' attention and sustain their focus, while simultaneously inspiring them to put in their best effort. As a result, learning outcomes improve.

Traditionally, students take notes in a long, linear format that covers all the material in a monotonous way, which can make the content feel boring. Monotonous notes can detract from the key topics of the lesson [17]. Therefore, the application of the mind mapping learning model in this research, particularly for the topic of hydrocarbon compounds, is highly beneficial [18]-[20]. Most of the material involves memorization and understanding chemistry concepts, which require strong memory retention [21]-[23]. Mind mapping helps students better grasp these key concepts [24], [25].

To overcome obstacles and make the learning process more effective and efficient, strategies such as using music (to relieve boredom and strengthen concentration through alpha waves), visual aids (to support students' visual learning abilities), and tailored content presentation based on how the brain works are useful [26]-[28]. Active involvement (intellectual, mental, and emotional) is also crucial. Siegel notes that classical music produces calming alpha waves that stimulate the brain’s limbic system and enhance cognitive functions, such as mathematics. In this context, teacher success is student success, and student success reflects teacher success [29], [30]. In education, this can be divided into two categories: context and content. Context refers to the preparation and quality of the learning environment, while content is the presentation of lesson material [31].

Previous studies conducted by Stokhof et al., [32] focused on the use of mind maps to improve the effectiveness of students' questions in the context of teacher guidance, with the main goal of improving students' understanding and learning outcomes through organizing information. However, these studies did not explore the application of mind mapping in a specific learning context or in combination with other elements, such as music. On the other hand, this study fills the gap by combining mind mapping and classical music to improve chemistry learning achievement, especially on the topic of hydrocarbons. This approach not only considers the organization of information through mind maps, but also uses classical music as a tool to improve students' concentration and focus, thereby enriching existing learning strategies and providing new contributions to the understanding of complex chemistry material.

Previous studies conducted by Burrai et al., [33] focused on the positive effects of listening to classical music in improving the condition of patients with heart failure, with an emphasis on the influence of music on relaxation and physical health. These studies did not discuss the application of music in the context of learning or its effects on student learning outcomes. On the other hand, this study fills this gap by exploring the use of classical music in the context of education, specifically in chemistry learning. This study combines classical music with mind mapping strategies to improve student learning outcomes, indicating that music is not only beneficial for physical health, but can also play a role in improving concentration and learning outcomes on complex learning topics, such as hydrocarbons.

This study offers novelty by integrating two creative learning approaches, namely mind mapping and classical music, which have not been widely applied simultaneously in chemistry learning. This strategy is designed to create a more enjoyable and effective learning atmosphere, considering the complexity of the hydrocarbon topic which is often a challenge for students. The urgency of this study lies in the need to improve students' understanding of chemical concepts, which are important foundations in science and technology. In addition, this method answers the demands of 21st century learning that encourages innovation in teaching approaches to improve learning achievement and student engagement holistically.

The purpose of this study is to evaluate the influence of using mind mapping learning accompanied by classical music on chemistry learning outcomes in the topic of hydrocarbon compounds among Class X students at State Senior High School 1 Tapung, Kampar.

2. RESEARCH METHOD

2.1. Research Design

The object of this study is Class X students at State Senior High School 1 Tapung, which consists of both the experimental and control classes. In the experimental class, the researcher implemented the mind mapping learning model, while in the control class, mind mapping was not used for teaching the topic of hydrocarbon compounds [34]-[36]. The subjects of this study are the researchers who applied the mind mapping learning model accompanied by classical music.

2.2. Population and Sample

The population of this study includes all Class X students at State Senior High School 1 Tapung, Kampar, consisting of five classes. Two classes were selected from the population, based on homogeneity testing using a variance test formula [37], [38]. After performing the homogeneity test, two classes were chosen with homogeneous test results. One class was randomly selected as the experimental class, and the other as the control class. The homogeneity test was conducted using pre-tests on redox reaction material [39].

2.3. Data Collection Technique

Data collection techniques in this study included documentation and testing. To ensure the quality of the test questions as tools for measuring chemistry learning performance, a trial was conducted with other students who were not involved in the learning process [40], [41]. The test questions were then analyzed for validity, discriminatory power, difficulty level, and reliability.

2.4. Data Analysis Techniques

The data analysis techniques in this study included both initial and final analyses. The initial data analysis involved a homogeneity test to ensure the variance between groups was similar, while the final analysis used hypothesis testing to examine the relationships and effects between the variables under investigation.

3. RESULTS AND DISCUSSION

3.1. Initial Data Analysis

The initial data was taken from the homogeneity test, which was based on the pre-test results from the redox reaction material. In determining the experimental and control classes, the researcher was given two classes, X3 and X5, by the chemistry subject teacher at State Senior High School 1 Tapung. The decision not to test all classes was due to the presence of two model classes that the researcher could not access. Additionally, Class X4 was not allowed to undergo the homogeneity test, as the teacher was concerned it might disrupt the effectiveness of the ongoing learning process. According to the chemistry teacher, Classes X3 and X5 were considered to have similar academic abilities. This was further supported by the preliminary data analysis, which is summarized in the initial data analysis table for both sample groups.

Table 1. Initial Data Analysis Results

Class	N	ΣX	$\bar{X}$	F count	F table	S gab	t count	t table (0.975)
Experiment	38	2255	59.34	1.05	2.77	8,6662	1,005	1.98
Control	40	2295	57.37					

From the table above, it can be seen that the calculated F value (F-count) is 1.05 and the F-table value is 2.77. Since F-count < F-table, this indicates that the two sample groups have the same variance (homogeneous). Next, a two-tailed test (1-α/2) was conducted to test the equality of the means, and the t-count value obtained was between -1.98 and 1.98 (-1.98 < 1.005 < 1.98). Therefore, it can be concluded that the basic abilities of the two groups are the same.

3.2. Instrument Test Data

The instruments used in this study were in the form of post-treatment tests, which evaluated the learning outcomes of students in the experimental class with the application of the mind mapping learning model, and in the control class, where mind mapping was not implemented. Before being used as an evaluation tool, the study instruments were pre-tested. The trial was conducted with 30 students in Class XI-Science 2. The results of the trial were then analyzed to assess the validity, reliability, difficulty level, and discriminatory power of the test questions.

The trial results for the test questions on the topic of hydrocarbon compounds, consisting of 20 questions, were analyzed for validity, reliability, difficulty level, and discriminatory power. The analysis showed that all 20 questions were valid, as they aligned with the research indicators. Regarding reliability, the trial analysis, conducted using the Anates computer program, yielded a reliability coefficient of 0.56, which falls under the very high category. As for the difficulty level, the analysis revealed that 100% of the questions met the acceptable criteria. In terms of discriminatory power, 20% of the questions were categorized as having poor discriminatory power, 45% were rated as good, and 35% had very good discriminatory power. Furthermore, when analyzing the correlation between item scores and total scores, it was found that 16 questions were not significantly correlated, while three questions (numbers 13, 14, and 19) had significant correlations, and one question (number 18) showed a very significant correlation.

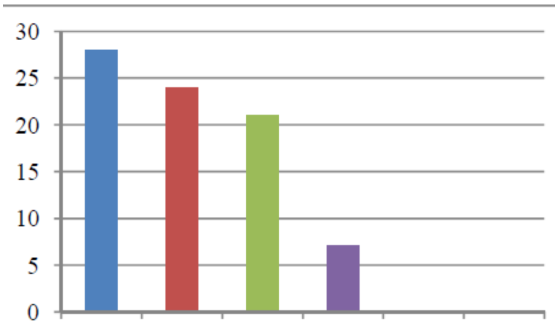

Figure 1. Graph of the Quality of the Multiple-Choice Answers

Figure 1 shows a graph depicting the quality of the multiple-choice questions used in this study. The graph illustrates the distribution of answers based on criteria such as difficulty level, discriminating power, and reliability of the questions. Each category of answer quality is marked with a certain percentage, which indicates the extent to which the questions can measure students' understanding and abilities. In the graph, most of the questions show good quality, with a proportion of questions having good and very good discriminating power, while a small number of questions show poor discriminating power. Overall, this graph provides an overview of the effectiveness of questions in evaluating student learning outcomes.

3.3. Final Data Analysis

The final data of this study were obtained from the difference between the pre-test and post-test scores in both the experimental and control groups. The pre-test and post-test scores for both groups are summarized in the following table:

Table 2. Results of Hypothesis Test Data Analysis

Class	N	ΣX	$\bar{X}$	Sgab	count	ttable (0.95)	Kp
Experiment	38	1310	34.47	11.38	3.43	1.68	14%
Control	38	970	25.52				

For the final data analysis, a one-tailed test (1-α) was used to compare the scores between the experimental and control groups. Based on the table above, the calculated t-value (t-count) is 3.43, while the t-table value is 1.68, so t-count > t-table. This indicates that the hypothesis, 'The Application of the Mind Mapping Learning Model Accompanied by Classical Music for Improving Chemistry Learning Outcomes on Hydrocarbon Compound Material in Class X at State Senior High School 1 Tapung, Kampar Regency,' is accepted, with an effect size of 14%.

3.4. Initial Data Discussion

The data used for the homogeneity test in this study were derived from the results of the homogeneity test on the redox reaction material. The processing of the homogeneity test results showed that the baseline abilities of the two classes were homogeneous, with an F-count value of 1.05 and an F-table value of 2.77, where F-count < F-table. This indicates that the two sample groups have the same variance (homogeneous). Next, a two-tailed test (1-½ α) was conducted to test for the equality of means, with α = 0.05. The analysis showed that the t-count value fell between -t-table and t-table (-1.98 < 1.05 < 1.98), confirming that the baseline abilities of both classes were homogeneous.

Before determining the experimental and control classes, I would like to explain that, according to the chemistry subject teacher at State Senior High School 1 Tapung, there are two model classes for Grade X among the five Grade X classes at the school. The subject teacher trusted me to conduct the homogeneity test only on Class X3 and X5. Class X4 was not allowed to undergo the homogeneity test due to concerns that it would disrupt the ongoing learning process, as the material was either already taught or being taught in that class. The determination of the experimental and control classes was then made through a random drawing, resulting in Class X5 as the experimental group and Class X3 as the control group. The experimental class received treatment with the application of the mind mapping learning model, while the control class did not implement mind mapping.

Before conducting this study, the researcher needed to ensure whether the test questions used as instruments were valid and suitable for use. Therefore, the questions for both the pre-test and post-test were first tested and analyzed. This was done to assess their validity, reliability, difficulty level, and discriminatory power, ensuring that the questions were appropriate for use in this study. A total of 20 objective questions were tested, and the trial was conducted with 30 students from Class XI Science 2. For validity testing, the researcher applied content validity, where the core of content validity is that a question is considered valid if it accurately measures the intended indicator. Based on the analysis results, it was found that all 20 tested questions met the required indicators, making 100% of the questions valid and 0% invalid. For a clearer explanation, we can refer to the diagram below.

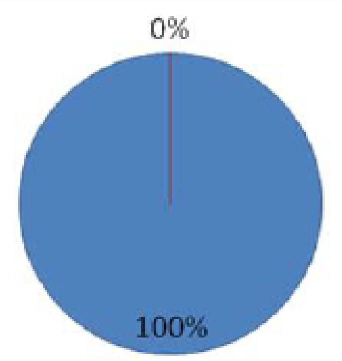

Figure 2. Validity Diagram Question

Based on the grouping of students into higher and lower groups, the higher-achieving group (KA) consists of 27% of the total 30 students, which equals 8 students: Imam S., Budiman M., Dina Ria R.S., Hendra T.S., Marihot I., Nurmala S., Suharningsih, and Wisnu P. The lower-achieving group (KB) also consists of 27% of the students, totaling 8 students: AA, AA, D, KS, LC, NR, SM, and SS.

Regarding the reliability analysis of the test questions, the reliability coefficient was found to be 0.56, which is considered very high. The analysis of question difficulty revealed that 0% of the questions were considered difficult, 100% were of moderate difficulty, and 0% were easy or very easy. In terms of discriminatory power, the analysis showed that 20% of the questions had poor discriminatory power, 45% had good discriminatory power, and 35% had very good discriminatory power.

After analyzing all the trial test questions, it was determined that 16 questions met the required criteria for use. However, 4 out of the 20 tested questions were not deemed suitable for use as test instruments, even though they fulfilled the validity criteria. These 4 questions were rejected because they had poor discriminatory power, despite being valid.

3.5. Final Data Discussion

The data processing for hypothesis testing shows that t-count > t-table, specifically t-count = 3.43 and t-table = 1.68. Therefore, the hypothesis, 'The Implementation of the Mind Mapping Learning Model Accompanied by Classical Music for Improving Chemistry Learning Outcomes on Hydrocarbon Compound Material in Class X at State Senior High School 1 Tapung, Kampar Regency,' is accepted with an effect size of 14%.

In calculating the average for the control class ($\bar{X}$), the number for Class X3 was divided by 38 students, even though the total number of students in the control class was 40. This was because two students did not take the pre-test and only participated in the post-test, so they were excluded from the sample for the study.

The improvement in student learning outcomes in the experimental class can be attributed to the active learning process involving mind mapping, which encouraged student engagement, independence, creativity, and imagination. Additionally, classical music played during the lesson contributed to balancing the use of the left and right hemispheres of the brain. The left hemisphere was engaged in thinking and analysis, while the right hemisphere was stimulated by the aesthetic experience of the music. This combination helped relax students' minds and reduced tension, allowing for a more enjoyable learning experience. As a result, students were less stressed, bored, or overwhelmed, which is often the case in chemistry lessons, where the material can seem dull and mentally exhausting. This scenario is not unique to chemistry but applies to other subjects as well. If the delivery of material is monotonous and does not foster an engaging learning environment, it may lead to disinterest in the subject matter.

This study has a positive impact on improving student learning outcomes by combining visual and auditory aspects to facilitate understanding of complex concepts. This approach can also increase learning motivation and create a more interactive and enjoyable learning atmosphere. However, this study has several limitations, such as the difficulty in ensuring the suitability of classical music to each student's preferences, which may affect the effectiveness of this approach. In addition, the implementation of this method may require training for teachers and adjustments to learning time, which can be challenging in classes with busy schedules or limited facilities.

4. CONCLUSION

Based on the analysis of the results of the study on student learning outcomes in hydrocarbon compound material in class X of State Senior High School 1 Tapung, Tapung District, Kampar Regency, it can be concluded that there is a significant difference between the learning outcomes of students who use the mind mapping learning model accompanied by classical music and those who use conventional learning (teacher as the center of learning). The results showed that students who learned using mind mapping and classical music showed higher scores compared to students who followed conventional learning. This indicates that the application of the mind mapping learning model supported by classical music can improve students' chemistry learning outcomes. In addition, the significant difference between the two groups indicates that the use of mind mapping with classical music is proven to be more effective in improving students' chemistry learning outcomes compared to more traditional learning methods. Further research can explore the application of similar strategies to other chemistry topics with high complexity, such as redox reactions or thermochemistry, to see the consistency of the effectiveness of this method. In addition, further research can evaluate the effect of using other types of music, such as modern or traditional music, to accommodate more diverse student preferences. Further studies are also recommended to measure the impact of this method on non-academic skills, such as creativity and critical thinking skills. Longitudinal research is also important to determine the long-term effects of the integration of mind mapping and classical music on student learning outcomes and motivation.

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