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The Effect of Work Card Media Integrated with the Group Investigation (GI) Cooperative Learning Model on Students' Learning Outcomes Improvement in the Colloidal System Topic

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Abstract
This study aims to determine the improvement of learning outcomes by using work card media in the GI (Group Investigation) type cooperative learning model on colloidal system material at Al-Hidayah Medan Private High School. The population used in this study were all students of class XI IPA Al-Hidayah Medan Private High School consisting of two classes. The research sample was randomly sampled from both classes, namely the experimental class I was given GI (Group Investigation) treatment with work card media and the experimental class II was given GI (Group Investigation) treatment without work card media. The improvement of student learning outcomes was calculated using the normalized gain form and the percentage of student learning success in the experimental class I was 80.2% while the percentage of student learning success in the experimental class II was 52.1%. The hypothesis test was conducted using the right-hand t-test and obtained t_{hitung} which was 3.124 while t_{tabel} was 1.670 for $\alpha = 0.05$ and db = 61. Thus t_{hitung} > ttabel, then Ha was accepted, namely the improvement in chemistry learning outcomes by using work card media in cooperative learning type GI (Group Investigation) was better than without using work card media in the application of the cooperative learning model type GI (Group Investigation).

1. Introduction

The teaching methods predominantly used by teachers tend to emphasize the teacher's role in the learning process. This condition causes students to be less actively involved in learning activities, resulting in learning outcomes that are often below expectations (Supraptama, 2011). Another effort to improve the quality of education is the creation of an engaging and effective teaching–learning process. In this regard, teachers are not only required to master the subject matter they teach but also to be able to

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select effective and efficient teaching methods or learning models for classroom implementation. Teachers should be capable of designing instruction by applying appropriate learning models that actively involve students in the learning process, thereby preventing the teaching and learning activities in the classroom from becoming monotonous (Firmina, 2024).

The use of the lecture method in chemistry learning is considered one of the factors contributing to students' lack of interest in studying chemistry. This assumption is supported by the results of a questionnaire distributed to 120 tenth-grade students at State Senior High School 4 Singkawang. The findings revealed that 62% of the students did not enjoy learning chemistry, 73% stated that the teacher's teaching method was boring, and 65% perceived chemistry as an abstract subject (Dewi Pratiwi, 2010). The questionnaire also indicated that 77% of the students desired a more interesting and engaging approach to chemistry learning.

Therefore, efforts to improve students' chemistry learning outcomes need to be developed in such a way that students become more interested in learning chemistry. One learning model that can be implemented for this purpose is the Group Investigation (GI) learning model. According to Slavin (2005), Group Investigation (GI) is a cooperative learning model in which teachers and students work together to construct the learning process. Students are required to be actively involved in various aspects of the teaching and learning activities, while the group functions as a medium for interaction in the development of learning concepts. One of the advantages of the *Group Investigation* (GI) learning model is its ability to increase students' self-confidence in applying their knowledge and skills for the benefit of their group (Rauuf Herlambang et al., 2024). In addition, it can improve intergroup relationships, thereby creating a positive and conducive learning environment (Dewi Pratiwi, 2010)

Previous research on the Group Investigation (GI) learning model was conducted by Meita Sari (2019). The results showed that the implementation of the Group Investigation model in chemistry learning improved students' academic achievement. The percentage increase in learning outcomes for the first experimental class was 48.5%, while that of the second experimental class was 28.1%. Therefore, it can be concluded that the cooperative learning model of the *Group Investigation* (GI) type, when used in conjunction with concept map media, had a positive effect on students' learning outcomes in the colloidal system topic.

Enjoyable and non-monotonous learning can be achieved through the use of various instructional media, including work cards. Work cards are learning media that contain practice questions organized at different levels of difficulty and are designed to accommodate students according to their intellectual

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abilities (Handono Warih, 2015). Work cards consist of both questions and answers, making students more interested in the learning process and helping to improve their understanding of the subject matter (Slavin, 2005).

According to the study conducted by Andrika (2020), the use of work cards in the Student Teams Achievement Divisions (STAD) cooperative learning model resulted in a 60.04% improvement in students' learning outcomes. Similarly, a study by Faridatul (2024) showed an increase in students' learning outcomes in the Team Games Tournament (TGT) cooperative learning model using work cards, with a mean score improvement of 64.28 ± 8.95.

Colloidal systems constitute the final chemistry topic taught to eleventh-grade students in the second semester of senior high school. Various types of colloids can be found in everyday life, many of which are widely utilized, such as jelly, milk, paint, foam, hair gel, and perfume. Colloidal phenomena also play an important role in numerous industrial processes, including the ceramic, plastic, soap, and detergent industries. These industries utilize colloids and their properties in the production of various products. The researcher selected the colloidal system topic because it is straightforward, conceptually rich, and closely related to examples commonly encountered in daily life (Holoho, 2023).

By integrating work card media into the *Group Investigation* (GI) cooperative learning model for the colloidal system topic, it is expected that greater variation in instructional strategies can be achieved, creating a more enjoyable and engaging learning environment. Such an approach is anticipated to help students understand chemistry concepts more easily. Therefore, the researcher is interested in investigating the effect of work card media integrated with the *Group Investigation* (GI) cooperative learning model on the improvement of students' learning outcomes in the colloidal system topic.

2. Materials and Methods

Mateials

Cooperative Learning

Cooperative learning is a learning model that emphasizes the formation of student groups. Each group consists of students with varying levels of ability, including high, moderate, and low achievers. This learning model promotes collaboration among students in solving problems and applying their knowledge and skills in order to achieve the intended learning objectives. Through cooperative learning, students are encouraged to work together, share ideas, and support one another in the learning process.

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According to David W. Johnson and Roger T. Johnson, the fundamental principles of the cooperative learning model are that each group member is responsible for everything carried out within the group and must understand that all members share the same goals. Each member is required to share tasks and responsibilities equally among the group members. Furthermore, every member is subject to evaluation, shares leadership responsibilities, and develops the skills necessary to learn collaboratively throughout the learning process. In addition, each member is individually accountable for the material assigned to and discussed within the group.

The characteristics of the cooperative learning model include students working collaboratively in groups to complete learning tasks according to the basic competencies to be achieved. Groups are composed of students with diverse ability levels, including high, moderate, and low achievers. In cooperative learning, rewards are generally focused on group performance rather than individual achievement. Moreover, discussion and communication are actively encouraged to enable students to share their abilities, learn critical thinking skills from one another, express their opinions, provide opportunities for peers to contribute their skills, assist each other in learning, and evaluate both their own abilities and roles as well as those of their peers (Rusman, 2010).

Learning Media

Another aspect that must be monitored in the implementation of instruction is the use of learning media and learning resources by teachers during the teaching–learning process. This is important because students possess diverse learning characteristics. Some students are auditory learners, others are visual learners, while some are kinesthetic learners. This diversity can be accommodated when teachers utilize multimedia and various learning resources in the classroom. Research conducted by the British Audio Visual Aids (BAVA) revealed that learning outcomes achieved without the use of instructional media account for only 13% of the total material presented. However, through the use of learning media, students' absorption of instructional content can be increased to as much as 86% (Rusman, 2010).

The word media originates from the Latin word medius and is the plural form of medium, which literally means “intermediary” or “means of conveying.” Thus, media serve as channels for delivering information or messages. According to Aida et al. (2020), media, in a broad sense, include people, materials, or events that create conditions enabling students to acquire knowledge, skills, and attitudes. Media are any forms of intermediaries or channels used to convey learning messages or information. In general, media are utilized to facilitate and enhance students’ learning processes.

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The presence of media in the teaching and learning process is of great importance. The complexity of the material delivered to students can be simplified through the use of media. As a result, students are able to understand the learning material more easily than they would without media support. The role of media becomes more effective when it is aligned with the instructional objectives (Faridatul, 2024).

In Arabic, media are defined as intermediaries or channels that convey messages from the sender to the receiver. Learning media encompass all tools and materials that can be used to achieve educational objectives, such as radio, television, books, newspapers, magazines, and other instructional resources. Media are anything that can be used to transmit messages from a sender to a receiver in ways that stimulate students' thoughts, feelings, interests, and attention, thereby enabling the learning process to take place effectively (Silvia Matondang, 2024).

To ensure that instructional media are effectively utilized to facilitate student learning, several principles should be considered. First, the media selected by teachers must be appropriate and directed toward achieving the intended learning objectives. Second, the media should be relevant to the learning content being taught. Third, the media should be chosen with consideration for both effectiveness and efficiency. Fourth, instructional media should be compatible with students' interests, needs, and learning conditions. Finally, the media used should match the teacher's ability to operate and implement them effectively in the classroom (Sanjaya, 2006).

Work cards are instructional media that contain practice exercises organized into different levels of difficulty. These cards include both questions and answers, making learning more engaging and helping students improve their understanding and abilities.

According to Siti Mahmudah (2015), there are several reasons for using work card media in the learning process:

1. Benefits of work card media in student learning the use of work cards can make instruction more attractive and capture students' attention, thereby increasing their learning motivation. Learning materials become more meaningful and easier for students to understand, enabling them to achieve learning objectives more effectively. In addition, teaching methods become more varied, reducing verbalism and preventing both students and teachers from becoming bored or fatigued. Work cards also encourage students to engage in more learning activities, foster independence, and develop creativity.
2. Students' cognitive development human thinking develops gradually from concrete thinking to abstract thinking and from simple thinking to more complex forms of reasoning. Therefore, work

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cards can support students' cognitive development by providing learning activities that correspond to their level of understanding.

In general, work cards consist of three levels: **Level 1** consists of questions aimed at developing essential concepts and learning materials *(yellow cards);* **Level 2** consists of reinforcement and application exercises designed to strengthen students' understanding *(green cards).*; **Level 3** consists of enrichment activities in the form of investigations, problem-solving tasks, puzzles, or educational games *(red cards).* Several aspects should be considered when designing work cards. First, the content or topic should be based on chemistry learning materials, particularly colloidal system concepts, and should include supporting illustrations to clarify conceptual ideas. Second, brief explanations of problems or concepts should be provided to assist students in solving the exercises. Third, the format and organization of work cards should be structured according to different levels of difficulty, such as easy, moderate, and difficult levels, or development, practice/application, and enrichment levels. Finally, prerequisite knowledge should be identified to ensure that students possess the fundamental concepts necessary to understand the material presented.

The use of work cards in chemistry instruction offers several advantages. They motivate students to solve problems based on their own experiences and support psychological learning principles by facilitating concept understanding through inductive and generalization approaches. Conceptual understanding becomes more meaningful because it is achieved through independent learning activities, enabling students to transfer their learning experiences to different situations. Furthermore, work cards allow students to progress continuously at their own pace, foster self-confidence, encourage cooperation through the exchange of ideas, stimulate creativity, and enhance memory retention (Anisa Masyitoh, 2024).

Methods

This study employed a quantitative research approach using an experimental research design involving two groups: Experimental Class I and Experimental Class II. The research design applied was a true experimental design, specifically the Pretest–Posttest Control Group Design. This design was selected to determine the effect of the treatment by comparing students' learning outcomes before and after the implementation of the instructional intervention. The research design used in this study is presented as follows:

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Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experimental I	T_1	X_1	T_2
Experimental II	T_1	X_2	T_2

Description:

X_1 : Treatment administered to Experimental Class I, namely the Group Investigation (GI) cooperative learning model using work card media.

X_2 : Treatment administered to Experimental Class II, namely the Group Investigation (GI) cooperative learning model without the use of work card media.

T_1 : Pretest score of Experimental Class I at the beginning of the study.

T_1 : Pretest score of Experimental Class II at the beginning of the study.

T_2 : Posttest score of Experimental Class I at the end of the study.

T_2 : Posttest score of Experimental Class II at the end of the study.

Data were collected through learning achievement tests, namely pretests and posttests, to measure the improvement of students' learning outcomes. The study involved two classes, each consisting of approximately 30 students. The sample was drawn from these two classes; therefore, all members of the population were included as research participants. The assignment of the classes was conducted through a simple lottery method. As a result, Class XI-2 was taught using the Group Investigation (GI) learning model with work card media, while Class XI-1 was taught using the Group Investigation (GI) learning model without work card media.

The instrument used in this study was an objective test. The research instrument consisted of learning achievement evaluations in the form of pretests and posttests administered to both Experimental Class I and Experimental Class II using the same instructional material. The test comprised 20 validated multiple-choice questions. Each item provided five answer options (a, b, c, d, and e), with only one correct answer. A score of 1 was awarded for each correct response, while an incorrect response received a score of 0.

3. Results and Discussions

Both sample groups participated in the learning process. Experimental Class I was taught using the Group Investigation (GI) cooperative learning model with work card media, while Experimental Class

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II was taught using the Group Investigation cooperative learning model without work card media. At the end of the instructional process, a posttest was administered to determine the improvement in students' learning outcomes. Based on the results of the study, the mean pretest score for Experimental Class I was 22.33 ± 7.00, while that of Experimental Class II was 21.81 ± 6.47. The mean posttest score for Experimental Class I was 84.50 ± 8.24, whereas the mean posttest score for Experimental Class II was 62.73 ± 9.61. Furthermore, the normalized gain (N-gain) for Experimental Class I was 0.8025, while that for Experimental Class II was 0.5213. These findings indicate that students who were taught using the Group Investigation (GI) cooperative learning model integrated with work card media achieved a greater improvement in learning outcomes than those who were taught using the same learning model without work card media.

Based on the calculations derived from the tabulated test results of both samples, the pretest and posttest scores of Experimental Class I and Experimental Class II are summarized in the following table:

Table 2. Mean Pretest and Posttest Scores

Class	Mean Score				Standard Deviation	
	Pre-test	Post- test	Pre-test	Post-test	Pre-test	Post - test
Experimental I	22,33	84,5	7	8,236	42,644	67,844
Experimental II	21,81	62,73	6,473	9,60	41,903	92,33

Table 2 shows that the mean pretest scores of Experimental Class I and Experimental Class II were relatively similar, indicating that the two groups had comparable initial abilities before the treatment was administered. After the instructional intervention, the mean posttest score of Experimental Class I was higher than that of Experimental Class II, suggesting that the use of work card media in the Group Investigation (GI) cooperative learning model contributed to greater improvement in students' learning outcomes.

Table 3. Hypothesis Test Results

Data Source	Class	$\overline{X}$	S^2	t_{hitung}	t_{tabel}	Conclusion
Gain Score	Experimental I	0,8025	0,153	3,124	1,670	Ha accepted and H_0 rejected
	Experimental II	0,5213	0,123			

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Based on the calculations, the obtained t-value was 3.124, while the critical t-value obtained through interpolation was 1.670 at a significance level of 5% ($\alpha = 0.05$) and degrees of freedom (df) = $n_1 + n_2 - 2 = 61$, corresponding to a 95% confidence level. The testing criterion was to accept the alternative hypothesis (Ha) if t_{count} > t_{table} and reject the null hypothesis (H_0); otherwise, H_0 would be accepted. Since t_{table} (3.124 > 1.670), the null hypothesis (H_0) was rejected and the alternative hypothesis (Ha) was accepted. Therefore, it can be concluded that students taught using work card media in the Group Investigation (GI) cooperative learning model achieved significantly better learning outcomes than students taught using the same Group Investigation (GI) cooperative learning model without work card media. This finding indicates that the integration of work card media effectively enhances students' learning achievement in the colloidal system topic.

The improvement in students' learning outcomes was calculated and is presented in the table below.

Table 4. Gain Experimental I dan Experimental II

Class	Gain
Experimental I	0,802
Experimental II	0,521

Based on the table above, the normalized gain (N-gain) score for Experimental Class I was 0.802, while the N-gain score for Experimental Class II was 0.521. These results indicate that the improvement in learning outcomes of students in Experimental Class I was categorized as high, whereas the improvement in learning outcomes of students in Experimental Class II was categorized as moderate.

Furthermore, the table shows that the improvement in chemistry learning outcomes of students taught using the Group Investigation (GI) learning model with work card media (Experimental Class I) was higher than that of students taught using the Group Investigation (GI) learning model without work card media (Experimental Class II).

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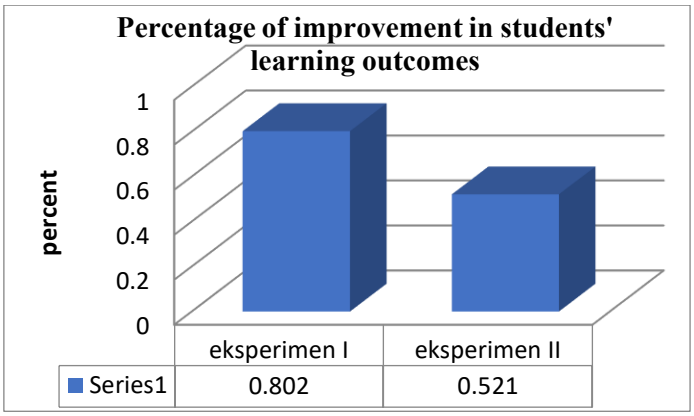

Figure 1. Percentage Improvement in Students' Chemistry Learning Outcomes in Experimental Class I and Experimental Class II

Based on the hypothesis testing conducted for both classes, it was found that the average percentage improvement in learning outcomes of students taught using the Group Investigation (GI) learning model with work card media (Experimental Class I) was 80.2%, whereas the average percentage improvement in learning outcomes of students taught using the Group Investigation (GI) learning model without work card media (Experimental Class II) was 52.1%. These findings indicate that the improvement in chemistry learning outcomes of students taught using the Group Investigation learning model with work card media was higher than that of students taught using the same learning model without work card media. In this study, the researcher tested the hypothesis by comparing the implementation of the Group Investigation (GI) cooperative learning model using work card media with the implementation of the same learning model without work card media.

The application of the Group Investigation cooperative learning model provided students with opportunities to select subtopics of interest, share knowledge with their peers, actively participate in the learning process, respect others' opinions, and compile investigation findings into final reports. The use of work card media supported the investigation process by providing students with clear guidance regarding the aspects that needed to be investigated. The combination of the learning model and instructional media produced positive effects on students' learning experiences.

The stage that most strongly encouraged student interaction was the subtopic investigation phase. During this stage, each group member was assigned specific responsibilities and examined various aspects of the selected subtopic. Students gathered information independently and summarized their findings in final reports, which were subsequently presented to the class.

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Based on the analysis of the gain scores, the average improvement in chemistry learning outcomes of students taught using the Group Investigation cooperative learning model with work card media was 0.802, corresponding to a learning improvement percentage of 80.2% on the colloidal system topic.

In contrast, students in Experimental Class II, who were taught using the Group Investigation cooperative learning model without work card media, tended to show slower enthusiasm during the investigation process. This may have occurred because there was no supporting instructional medium to guide the investigation activities. Nevertheless, the Group Investigation learning model still enhanced interaction and cooperation among group members.

As shown in grafik 1, the mean posttest scores of Experimental Class I and Experimental Class II were 84.50 and 62.73, respectively, resulting in a difference of 21.77 points. The gain score analysis revealed that the average improvement in chemistry learning outcomes of students taught using the Group Investigation cooperative learning model without work card media was 0.521, corresponding to a learning improvement percentage of 52.1% on the colloidal system topic. Therefore, both the average learning outcomes and the improvement in learning outcomes of Experimental Class I, which was taught using the Group Investigation cooperative learning model with work card media, were higher than those of Experimental Class II, which was taught using the same learning model without work card media. In other words, students who learned through the Group Investigation learning model supported by work card media achieved better learning outcomes than those who learned through the Group Investigation model alone.

In Experimental Class I, work card media were integrated into the Group Investigation learning process to create a more effective and enjoyable learning environment. During group discussions, each group received work cards designed according to different levels of difficulty that matched students' abilities. The use of work card media increased students' enthusiasm for group discussions. Students showed curiosity and interest even before receiving the cards, motivating them to explore the content and attempt to solve the problems according to their abilities..

Since cooperative learning groups were heterogeneous, work card media helped students with lower levels of understanding to participate more actively and achieve learning outcomes according to their capabilities. The different levels incorporated into the work cards required students to complete lower-level tasks before progressing to more challenging ones. Consequently, strong cooperation and mutual assistance among group members were essential. During the first meeting, some students were still reluctant to collaborate in solving the problems provided on the work cards. However, during the

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second meeting, students became increasingly interested in the work card media and demonstrated greater enthusiasm in completing the assigned tasks. By the third meeting, students consistently showed high motivation and active participation, as reflected in their group presentations. Students with higher academic abilities voluntarily guided their peers and helped them understand the questions, fostering collaboration and teamwork. The work cards consisted of three levels: the first level contained developmental questions related to the learning material (yellow cards), the second level contained reinforcement and application exercises (green cards), and the third level contained enrichment activities in the form of investigations (red cards). These structured activities encouraged students to work cooperatively, discuss concepts they had not yet fully understood, and support peers with lower academic abilities. As a result, students' learning motivation and academic achievement improved.

The findings indicate that the Group Investigation cooperative learning model supported by work card media helped students remain focused and facilitated the investigation process because the cards contained guiding questions that directed students' inquiry activities. However, the implementation of this learning model was constrained by limited instructional time. Each phase of the learning process—including explaining the material, conducting investigations, preparing reports, presenting findings, and evaluating outcomes—required a considerable amount of time. This finding is consistent with previous studies reporting that insufficient instructional time is one of the major challenges in implementing the Group Investigation learning model. Martha also reported that students taught using work card media in the Group Investigation cooperative learning model achieved better learning outcomes than those taught without work card media.

The right-tailed t-test analysis yielded a calculated t-value (tcount) of 3.124, whereas the critical t-value (ttable) at a significance level of 5% ($\alpha = 0.05$) and 61 degrees of freedom was 1.670. According to the testing criteria, the alternative hypothesis (Ha) is accepted if tcount > ttable and the null hypothesis (H_0) is rejected. Since 3.124 > 1.670, the null hypothesis was rejected and the alternative hypothesis was accepted.

Therefore, it can be concluded that students taught using work card media within the Group Investigation (GI) cooperative learning model achieved significantly better learning outcomes than students taught using the same learning model without work card media. Based on the findings of this study, it can be concluded that the use of work card media in the Group Investigation (GI) cooperative learning model is more effective in improving students' learning outcomes on the colloidal system topic than the use of the Group Investigation model without work card media. These results demonstrate that

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integrating work card media into cooperative group investigation learning can effectively facilitate the achievement of chemistry learning objectives.

5. Conclusions

Based on the results of the study, it can be concluded that the use of work card media in the Group Investigation (GI) cooperative learning model had a significant positive effect on students' learning outcomes compared with the implementation of the Group Investigation (GI) cooperative learning model without work card media on the colloidal system topic. Therefore, the alternative hypothesis (Ha) was accepted. The findings showed that the mean pretest score of Experimental Class I, which was taught using the Group Investigation learning model with work card media, was 22.33 ± 7.00, while the mean pretest score of Experimental Class II, which was taught without work card media, was 21.81 ± 6.473. After the treatment, the mean posttest score of Experimental Class I increased to 84.50 ± 8.236, whereas the mean posttest score of Experimental Class II increased to 62.73 ± 9.608.

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