IJIS Edu : Indonesian J. Integr. Sci. Education, 7 (2) 2025

Volume 7 Issue 2 , July 2025
P-ISSN: 2655-2388, E-ISSN: 2655-2450

The Application of Experimental Methods to Improve the Learning Outcomes of High School Students on Colloid Material

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Abstract: The low ability of students to achieve learning outcomes in chemistry concepts, including colloid material, is influenced by various factors such as limited study time, inadequate facilities, and teaching methods that do not align with the material. One effective method for enhancing student learning outcomes is the experimental method. This study aims to assess student activity, learning results, and feedback on the learning process for colloids. Utilizing a descriptive qualitative approach, the research involved 22 students from class XI MIA 2 at SMA Negeri 1 Terangun, selected through purposive sampling. Instruments included observation questionnaires, learning outcome tests, and student feedback questionnaires. Content validation has been conducted for all instruments by one expert and one practitioner, who have declared them valid and feasible to use. Results showed increased student activity with 94% at the second meeting and 96% at the third. Learning outcomes improved, with average completion rates rising from 64% at the second meeting to 86% at the third. Feedback indicated 61% strongly agree, 36% agree, and 3% somewhat agree regarding the experimental method. This study concludes that the experimental method for exploring the types and properties of colloids can enhance student activity and learning outcomes.

Keywords: Colloid System, Experimental Learning Method, High School Students, Learning Outcomes

How to cite this article :
Gani, A., Wati, A., Winarni, S., Syahrial, S., & Nasir, M. (2025). The Application of Experimental Methods to Improve the Learning Outcomes of High School Students on Colloid Material. *IJIS Edu : Indonesian Journal of Integrated Science Education, 7*(2). doi:http://dx.doi.org/10.29300/ijisedu.v7i2.5383

1. Introduction

Education is a process of behavioral change in individuals or groups resulting from experiences through activities and training (Partono et al., 2017). The success of the teaching and learning process is a primary goal in implementing education in schools. Chemistry is a mandatory subject for high school students, particularly in the science track (Fajri et al., 2012).

Chemistry is one of the subjects taught in high school. However, some students find it difficult and try to avoid it, making it less appealing to many learners (Adlim et al., 2025; Maryam et al., 2018). This issue arises because students struggle to understand the material presented by teachers, especially concerning colloidal systems. In essence, colloidal systems are not inherently difficult as they are commonly encountered in daily life; for example, many people in Terangun engage in activities related to colloidal systems, such as making coconut milk and producing milk. However, a significant factor contributing to the difficulty in grasping this material is that it is taught at the end of the learning period, leading to insufficient coverage, with teachers often assigning tasks without prior explanation.

Essentially, improving learning outcomes requires various breakthroughs in curriculum development, teaching methods, and the provision of educational facilities and infrastructure. The surrounding environment can significantly influence success and serve as a supportive factor. A comfortable learning space facilitates student concentration. Teachers play a crucial role in enhancing learning outcomes by implementing innovative teaching processes that encourage optimal independent learning both inside and outside the classroom. The use of effective teaching methods or approaches is vital for increasing efficiency and effectiveness in educational renewal (Muslim & Erlinawati, 2016).

Based on initial interviews with chemistry teachers at SMAN 1 Terangun, it was noted that the delivery of chemistry material, particularly on colloids, remains teacher-centered, with very limited practical methods, and relying heavily on available learning resources. This results in a teaching approach primarily based on lectures, where students passively receive information from a single source. Such conditions often lead to boredom among students, making them passive and less motivated to engage in learning. To address this, it is essential to develop an effective and enjoyable learning pattern that enhances motivation, activity, and active involvement of students in the learning process.

A crucial factor in the teaching and learning process is innovation in learning. When applied effectively, it can spark student interest and enhance understanding of the material being taught. According to Nainggolan et al., (2020) and Budiariawan (2019), choosing and utilizing appropriate teaching models can create meaningful learning experiences and prevent boredom during lessons. The

Online ISSN 2655-2450 | Print ISSN 2655-2388

implementation of experimental methods encourages students to explore information through real-life problems. Students are required to engage more actively by observing, identifying, drawing conclusions, and communicating their research or experimental results. The experimental method in chemical education involves students conducting experiments to verify what they are learning (Winarni et al., 2022; Jusniar et al., 2021).

Strategies to enhance learning motivation and mastery of outcomes include leveraging the surrounding environment. One effective innovation is implementing experimental methods using simple, readily available materials. This approach boosts students' confidence in their conclusions drawn from experiments, rather than merely listening to teachers (Partono et al., 2017). According to Masters (2013), based on Dale's learning pyramid, hands-on practice during learning can lead to an average retention rate of 75%. Experimental methods are frequently used in science education, significantly enhancing skill acquisition. The positive impact of experiments on critical thinking has also been confirmed by Laliyo et al. (2022) and Zendler & Greiner (2019), highlighting their effectiveness in fostering deeper cognitive engagement.

One study that utilized experimental methods was conducted by Mayangsari et al. (2014). In Cycle I, the average student learning activity percentage was 65.53% (active category), with a learning outcome of 55%. In Cycle II, there was an improvement, with an average activity percentage of 85% (very active category) and a learning outcome of 85%. Based on the background above, it is necessary to conduct learning using experimental methods on the colloid topic with materials that are available to the students.

2. Method

The research employed a descriptive qualitative method aimed at investigating conditions, situations, events, and activities, which are then presented in report form. This study focuses on student learning outcomes and their responses to the implementation of experimental methods in colloidal systems.

The research and data collection were conducted at SMA Negeri 1 Terangun, located in the highlands of Gayo Lues Regency, from February to March 2024. The quantitative approach involves a defined population and sample, while qualitative research comprises research subjects (Yusuf, 2014). The subjects for the study on the application of experimental methods to improve student learning outcomes in colloidal systems were 22 students from class XI MIA 2.

To collect the necessary data, researchers must use appropriate methods to achieve more efficient results. The methods employed in this study include: Student Observation, Learning Outcome Tests, and Student Response Questionnaires.

Online ISSN 2655-2450 | Print ISSN 2655-2388

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The data collection instruments used in this study include: Student Observation Sheets, aimed at observing student activities conducted by the chemistry teacher as the observer; Learning Outcome Tests, which consist of questions administered after the learning process to assess student understanding of the material (Arikunto, 2010). A total of 10 multiple-choice questions will be provided. Additionally, Student Response Questionnaires are used to gauge student feedback on the implemented methods, measured using a Likert scale

The data analysis techniques used in this study include:Student Activity: Student activity can be assessed using observation sheets by marking checklists in the provided columns. The scoring description for student engagement during learning activities is as follows: (1) poor, (2) moderate, (3) good, (4) very good. The assessment results are then calculated using a percentage formula. Learning Outcome Tests: The data obtained from the study can be processed using the same percentage formula (Equation 1) and compared against assessment criteria. Student Response Questionnaires: This questionnaire measures students' opinions on interest, enjoyment, and ease of understanding the material presented. Responses are collected from all students after the learning process to determine their feedback. The percentage of student responses can also be calculated using percentage formula (Suwahono, 2012). Total scores are categorized into levels of agreement, such as "Strongly Agree" or "Strongly Disagree." Student responses are considered acceptable if the percentage is "≥" 61%. Documentation: Documentation involves collecting data through photos of activities, capturing the teaching and learning process from start to finish. This serves as evidence that the researcher has conducted the study.

3. Result and Discussion

This research was conducted over three meetings, including two direct observations of student activity by the chemistry teacher as the observer. The instruments used included activity observation sheets, written test questions, and student response questionnaires. The initial learning activities began with greetings, welcoming students, prayer, attendance, and providing students with aperception and motivation to encourage their enthusiasm for learning. The core activities involved exploring students' knowledge through observing, questioning, reasoning, experimenting, and communicating regarding the material to be studied.

Students were then divided into several groups to conduct experiments, following the procedures outlined in the provided Student Worksheet (LKPD). During the concluding activities, students summarized the results of their experiments with guidance from the teacher, participated in a collective reflection,

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completed a post-test after the experiments, and concluded the session with a closing prayer.

Throughout the learning process, the observer monitored student activity from start to finish, evaluating aspects outlined in the provided questionnaire. The observer also administered tests to assess student outcomes and distributed questionnaires to gather student feedback on the learning experience over the three meetings related to colloidal systems.

1. Student Activity

The results of student activity during the learning process using experimental methods were assessed by the observer, who is the chemistry teacher in this study. Student activities were observed from the initial activities, through the core activities, to the concluding activities. The outcomes of student activity are presented in Table 1.

Table 1 Results of Student Observations

Results of observations from meetings I and II		Average (%) of meetings I and II		Category
I	II	I	II	
49	50	94	96	Very good

Activity assessment is conducted using an observation sheet that utilizes a Likert scale ranging from 1 to 4. For instance, in the activity of preparing experimental tools and materials, if students follow the instructions outlined in the student worksheet, they can earn a maximum score of 4. Student activity showed significant improvement during the second meeting, with an average score of 94%, and further increased to 96% in the third meeting. All aspects of activity met the "very good" criteria, indicating that the success indicators of this study have been achieved. Throughout the learning process, students demonstrated high levels of engagement, enthusiasm, and motivation while participating in the experimental methods applied (Ahmadiyanto, 2016).

2. Student Learning Outcomes

Student learning outcomes can be assessed through the post-test scores administered during the second and third meetings after the experimental methods were implemented. A total of 10 questions were provided, and the scores obtained were compared to the Minimum Competency Criteria (KKM) set at 75. The purpose of this assessment was to evaluate the results achieved by students and to determine the extent to which the indicators were met.

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Table 2 Post Test Learning Results 1

Learning outcomes achievement category	Number of students	Acquisition of learning outcomes (%)
Complete	14	64
Incomplete	8	36

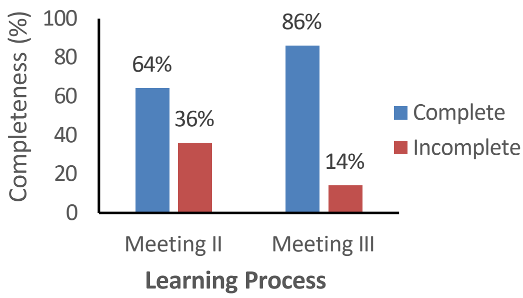
Based on Table 2, the learning outcomes of students during the second meeting indicated that many students had not yet achieved mastery after the practical session. The reason for this lack of completeness is attributed to many students being less focused and frequently leaving the classroom during the learning process, which made it difficult for them to answer the provided questions (Nurqomariah et al., 2015).

Table 3 Post Test 2 Learning Results

Learning outcomes achievement category	Number of students	Acquisition of learning outcomes (%)
Complete	19	86
Incomplete	3	14

Based on Table 3, the mastery of student learning outcomes in class XI MIA 2 on the colloidal systems material, using experimental methods, was 64% in the second meeting, with a non-mastery rate of 36%. In the third meeting, as shown in Table 3, mastery improved to 86%, while the non-mastery rate dropped to 14%. Although there was an increase in student learning outcomes by the third meeting, some students still did not achieve mastery.

Students who achieved mastery did so because they were engaged and active during the learning process, demonstrating an understanding of the concepts taught, which helped them answer the test questions confidently. However, some students did not reach mastery due to a lack of focus and participation, which hindered their understanding of the concepts being explained, resulting in test scores below the mastery threshold. Many students successfully answered questions related to types and properties of colloids after conducting experiments, but there were still misconceptions among some students regarding differentiating solutions, suspensions, and colloids, leading to incorrect answers.



Online ISSN 2655-2450 | Print ISSN 2655-2388

Based on the graph of learning outcome mastery from the second and third meetings using experimental methods, the results were very positive. Mastery increased by approximately 22% in the third meeting compared to the second. In contrast, the mastery achieved by students on colloidal systems material, when the learning process was predominantly teacher-centered, showed only a modest improvement of around 5%. According to Masters (2013), based on Dale's learning pyramid, when students merely listen to lectures, the average retention rate is only 5%. In contrast, when students engage in hands-on practice related to the learning material, the retention rate can rise to 75%.

Based on the research findings, student mastery in learning outcomes improved through the application of experimental methods. When the methods used in the learning process are implemented effectively, student learning outcomes tend to be better (Thien et al., 2021; Putri et al., 2017). Engaging in hands-on experiments significantly influences students' learning experiences, fostering enthusiasm, active participation, and a greater enjoyment of the learning process. This positive engagement makes learning more enjoyable for students.

3. Student Responses

The results of student responses were gathered from questionnaires administered to each student in class XI MIA 2. This questionnaire was given after the completion of the learning process and contained 7 questions aimed at assessing students' feedback on the implementation of experimental methods in the colloidal systems material.

Table 4 Results of Student Responses

Results of Student Responses Based on Categories(%)				
SA	A	SA	DA	SDA
65	33	2	0	0

Based on the results in Table 4., students provided a predominantly positive response, expressing their enjoyment of the learning process using experimental methods. This was confirmed by observations of student activity during the lessons. Throughout the implementation of the experimental method, students engaged seriously and took their time completing assigned tasks. They also noted that their interest in learning increased due to experiments related to everyday life experiences (Assriyanto et al., 2014).

The need for contextual learning during the teaching process is crucial, as it helps teachers connect the material being taught to real-life situations (Zulkifli, 2018). According to Table 4., students responded with varying degrees of agreement: 65% strongly agreed (SA), 33% agreed (A), and 2% somewhat agreed (SA). These results indicate that experimental methods can positively influence students' interest in future learning (Sry, 2018).

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4. Conclusion

Using the experimental method to learn chemistry with colloids effectively enhances student activities and learning outcomes, while also demonstrating meaningful learning through positive feedback from students. Therefore, the experimental method offers a promising pedagogical strategy to enhance chemistry learning in high school settings, especially when aligned with contextual materials and active student participation

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