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Blended Learning-Based Guided Inquiry: Strengthening the Science Process Skills Through Colloid Learning

Iriani Bakti[1], Reni Hafizah[1], Arif Sholahuddin[1*]

[1] Chemistry Education, Faculty of Education and Teaching Science, Lambung Mangkurat University, Banjarmasin, Indonesia.

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Corresponding Author:
Arif Sholahuddin
arif.science.edu@ulm.ac.id

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Abstract: Science process skills play a crucial role in constructing knowledge and fostering the ability to independently solve problems. Despite their significance, the science process skills of students across various educational levels remain at a relatively low level. This research seeks to evaluate the science process skills of students and their responses to learning about colloids through a blended learning-based guided inquiry approach. The research employs a quasi-experimental design with a pretest-posttest control group setup. The sample, drawn through cluster random sampling, consists of students from Class XI MIPA 1 at SMAN 11 Banjarmasin, divided into two groups. Group A, the experimental class, engages in blended learning-based guided inquiry, while Group B, the control class, follows the guided inquiry model. Data collection involves tests to assess students' science process skills and non-tests to gauge their responses. The analysis entails descriptive techniques and t-tests. The findings indicate (1) discernible differences in science process skills between classes employing blended learning-based guided inquiry and guided inquiry alone, and (2) a positive response from students towards the blended learning-based inquiry model.

Keywords: Blended learning; Colloids; Guided inquiry; Science process skills

Introduction

Science process skills (SPS) are the ability of scientists to understand and develop science through the scientific method. In the learning context, SPS represents abilities employed by students for the examination or investigation of problems, issues, questions, or scientific phenomena encountered during the learning process (Duruk et al., 2017). SPS aims to enhance students' receptivity to learning encounters by incorporating scientific methodologies (Idiege et al., 2017). SPS indicators include observing, grouping, interpreting, forecasting, formulating problems, stating hypotheses, planning experiments, conducting experiments, applying concepts, and communicating (Rustaman, 2005).

Science process skills are important for building knowledge and being applied in learning. Building knowledge is not only obtained through theory but can also be obtained from experimental activities or activity-based learning. This is where science process skills can arise because these skills contain scientific methods or steps in searching, gaining new knowledge, and developing the knowledge possessed (Mardianti et al., 2020). SPS is important from the level of Basic Education to higher education. This is evident from research conducted by Sholahuddin et al. (2020), Lusidawaty et al. (2020) said that there is an increase in the science process skills of elementary-level students (SD). Kelana et al. (2020) also stated that there was a significant increase in SPS in PGSD students.

SPS is a combination of thinking activities and skill activities. The most important role in the development of science process skills is inquiry skills, inquiry-based teaching can develop critical and creative thinking skills (Cetinkaya & Ozyürek, 2019). This is in line with Sholahuddin et al. (2017) that guided inquiry is the most recommended model because of its best performance in achieving SPS.

Guided inquiry learning can help learners develop individual responsibility and the ability to understand concepts (Abdurrahman et al., 2020). Inquiry learning is

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a learning activity that maximizes the entire ability of students to search and investigate something (objects, humans, or events) systematically, critically, logically analytically so that they can formulate their discoveries with full confidence (Sartini, 2020).

The 4.0 education requires changes in the learning process to be more effective and can be done anywhere, one of which is online learning, such as during the COVID-19 pandemic. It has required all educational institutions, to use online learning methods without exception to ensure that the learning process continues even though it must be performed in their respective homes (Cahyani et al., 2020).

The implementation of online learning provides challenges for educational actors, such as educators, students, and institutions, and even provides challenges for the wider community such as parents. In its implementation, educators must find ways to continue to deliver learning materials and be easily accepted by students. Likewise, students are required to be able to adjust to situations and conditions like today, one of which is mental readiness (Salsabila et al., 2020). In online learning, of course, it cannot be separated from the role of technology. Technology is very influential on ongoing learning because technology functions as a medium of learning to make it easier for teachers and students (Salsabila & Agustian, 2021; Salsabila et al., 2020; Widoyono & Millati, 2021).

Teaching and learning activities at all levels can be carried out at the homes of their respective students through online media such as E-Learning. The use of e-learning has a good influence on the learning process (Su'uga et al., 2020; Rahayu & Pahlevi, 2021; Spiritual & Zulfah, 2021).

Teachers can also provide measurable tasks but still ensure that each day the student's learning is carried out step by step from the task. Many other innovations can be made by educators to ensure that learning continues and students get knowledge according to the curriculum that has been prepared by the government, and many online applications can be used in educational assessments (Mulatsih, 2020).

Several researchers have made efforts to train SPS, including Sholihah et al. (2019) and Fitriyani et al. (2017) that student's science process skills have improved after applying the guided inquiry learning model from sufficient criteria to high criteria. Mumtaza et al. (2023) that the analysis results of the SPS aspects in the student worksheets, it can be seen that students can apply each aspect with a percentage of 80.67%. Sakdiah et al. (2022) stated that STEAM learning is proven to increase SPS judging from the difference in average SPS score. Abdjul et al. (2022) prove that the Ryleac model science learning device assisted by PhET has a positive effect on the science process skills of students who were previously considered poor. Research that has been carried out to train SPS is research conducted offline or face-to-face in the classroom but this research is carried out using a blended learning-based learning design (Trisnowati et al., 2020 & Pratiwiningsih et al., 2021).

Pandemic conditions make it impossible for learning to be done face-to-face only. Therefore, blended learning is one solution if learning cannot be done face-to-face. Blended learning is a learning model that combines face-to-face and online meetings (Sulisworo et al., 2016; Frafika et al., 2018). Sutanti et al. (2021) stated that blended learning has a significant influence on critical thinking skills. Badrus et al. (2021) in their study wrote that using a blended learning model affects student learning outcomes. Utami (2020) and Vonti et al. (2019) report that blended learning contributes to student learning achievement.

The success of blended learning in achieving learning outcomes because it provides a more personalized and flexible learning experience, allowing students to learn according to their learning rhythm, increasing student engagement and interaction with technology, being more economical costs compared to traditional classes, and providing experience in using digital tools (Hua et al., 2013; Juhi et al., 2023; Otieno & Osoro, 2014).

Learning resources can be presented and studied first by students via e-learning, while meetings in class or the laboratory focus on understanding the fundamental concepts being studied. The blended learning approach has been proven very efficient in wide fields of learning (El-Mowafy & Hassan, 2023; Juhi et al., 2023; Sholahuddin et al., 2023). Thus, the blended learning approach becomes a rational choice to improve students' knowledge and skills.

Students experience difficulties in the learning process including how to train SPS if it is not possible to conduct in-person meetings, so they are given an alternative by doing blended learning. Chemical matter has a close relationship with concepts, so it requires a very basic conceptual understanding to build other related concepts. Chemistry learning also emphasizes providing hands-on learning experiences through the use and development of science process skills. When chemistry learning takes place in schools, most students have a low understanding and application of concepts (Sariati et al., 2020). This is because in chemistry learning practicum activities are carried out at the end of learning, so students tend to imagine abstract concepts at the beginning of learning. This situation makes students tend to find it difficult to understand chemistry learning in school.

Colloid subject matter is one of the chemistry learning materials that is often completed by rote memorization method alone, even though colloid material is basically contextual and directly related to daily life (Ilyas et al., 2019). We can relate colloid matter to daily life, for example in the water purification process, where the water purification process is the utilization of colloid properties. As a result, learning was not able to train students' SPS.

Several studies have reported the effectiveness of the guided inquiry learning model in enhancing science process skills (SPS). However, it is commonly implemented in face-to-face classrooms without being combined with online activities. Numerous research findings indicate the reliability of e-learning in supporting the achievement of learning outcomes, including both knowledge and skills. The combination of these two approaches is expected to result in a strengthened attainment of student learning. This research combines guided inquiry and blended learning (face-to-face & and online) to strengthen students' SPS. The results of this study are expected to provide knowledge or skills for teachers to be able to train SPS through chemistry learning in the classroom.

Method

The The design of this study uses quasi-experimental research. The design of this study is a pretest-posttest control group design in which experiments and control classes are given a pre-test before learning and a post-test at the end of the study. The population of this study was students of class XI science of SMAN 11 Banjarmasin with samples taken from class XI MIPA at SMAN 11 Banjarmasin, namely class XI MIPA 1 consisting of 32 students which were divided into 2 groups, A and B. The technique used in this study is cluster random sampling to determine the sample with certain considerations so that the sample is suitable as a sample.

Learning is carried out using a guided inquiry model with blended learning. The blended learning process itself is carried out by each student and is carried out through online media (online). Teachers conduct learning using the e-learning method, namely learning to utilize information and communication technology. The teacher provides an opportunity for students to discuss the material and assist students in understanding the material that has been taught. Teachers also provide a variety of online assignments and activities designed to help students master the material they have been taught and apply online learning strategies to create an interactive learning environment. The research steps are presented in Figure 1.

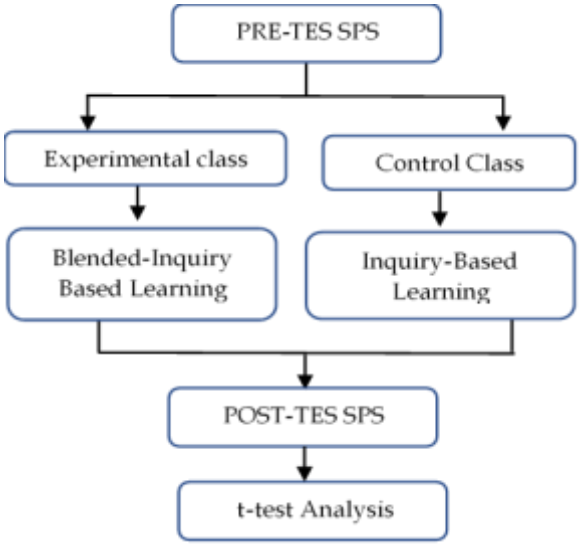

Figure 1. Research steps

The stages of blended learning-based guided inquiry learning are presented in Table 1.

Table 1. Stages of Guided Inquiry

Blended Learning-based Guided Inquiry	Activities teacher	Activities student
Orientation	Teachers deliver learning materials	Submission of materials through WhatsApp Group
Formulating the Problem	The teacher allows the learner to formulate the problem	Students formulate a problem of a phenomenon
Formulating a Hypothesis	The teacher allows the learner to formulate hypotheses	Student's formulate hypotheses or temporary answers
Collecting Data	Teachers tell learners to collect information	Students collect information from a variety of sources
Testing the Hypothesis	Teachers guide students to do a practicum	Students analyze temporary answers with practicum
Formulating Conclusions	The teacher gives each group a chance to conclude	Students convey the conclusions obtained through Group WhatsApp

The test instrument used in this study serves to measure the ability of science process skills in colloid materials. The test instrument used to measure the ability of student's science process skills is in the form of

a description test consisting of 8 questions. Questions number 1, 3, 4, 6, 7, and 8 consist of 1 question item with indicators of observing, interpreting, forecasting, conducting experiments applying concepts, and communicating. While questions number 2 and 5 consist of 2 questions with indicators grouping, planning experiments, formulating problems, and hypothesizing. The measured indicators are observing, grouping, interpreting, forecasting, formulating problems, stating hypotheses, planning experiments, conducting experiments, applying concepts, and communicating.

Non-test instruments were used in the form of student response questionnaires. The questionnaire is prepared to find out the response of students after being given treatment. In filling out this questionnaire is carried out individually, students are not allowed to ask questions or pay attention to other friends about the questionnaire answers. This instrument is first validated to obtain valid test results. The validity of the contents of the SPS test instrument and questionnaire sheet is determined based on the assessment and consideration of the assessor. The validity of the content will be carried out by asking for consideration and assessment of experts, namely four people from lecturers of Chemistry Education and one chemistry educator.

Instruments that are already valid are then tested before being used in research to determine the level of reliability. Based on the calculation results with the Alpha Cronbach formula, the degree score of the critical thinking ability test instrument of 0.8 0 with a high category, and the cognitive learning result test instrument with calculations using the KR 20 formula was obtained 0.51 in the medium category.

The analytical techniques used are inferential and descriptive. The t-test used in inferential analysis needs to meet the requirements, namely the normality and homogeneity test. The t-test aims to determine the presence or absence of differences produced between the control group and the experimental group.

The SPS score criteria used are the highly skilled category with a score of 81-100, the skilled category with a score of 61-80, the moderately skilled category with a score of 41-60, the less skilled category with a score of 21-40 and the unskilled category with a score of 0-20. Based on the SPS test results, an increase was obtained from the unskilled and less skilled category to the skilled and highly skilled category (Widoyoko, 2017).

The criteria for student response scores used are the very positive category with a score of 42-50, the positive category with a score of 34-41, the category is quite positive with a score of 26-33, the less positive category with a score of 18-25 and the category is very less with a score of 10-17. Based on the data obtained, students have a good response with an average score of 40.13 which means it is included in the positive category (Widoyoko, 2017).

Result and Discussion

This research obtained data concisely on students' science process skills ability, communication skills, and student response to the implementation of a blended learning-based guided inquiry learning model on colloid material.

The student's science process skills (SPS) data is summarized in Table 2. The average pre-test scores for both of experimental and the control classes are less category while the average post-test scores are skilled category.

Table 2. The Average SPS Score of Students

Score	Experiment Class		Control Class	
	Pre-test	Post-test	Pre-test	Post-test
Lowest	8.00	64.00	4.00	60.00
Highest	28.00	100.00	24.00	96.00
Average	18.67	81.87	16.27	73.33

Students' science process skills have improved in both experimental and control classes as shown by N-gain scores. The SPS of students of the experimental class increased higher than the control class as presented in Table 3. The N-gain scores of the experimental and control classes are high and moderate categories respectively.

Table 3. SPS N-gain Interpretation of Students

Class	Average N-gain	Category
Experiment	0.78	High
Control	0.68	Moderate

The results of the t-test of students' SPS of experimental and control were represented in Table 4.

Table 4. T-test Result

Result	Class	dB	t-count	t-table (α = 0.05)	Conclusion
Pre-test	Experiment	15	0.988	1.771	There is no difference
	Control	15			
Post-test	Experiment	15	2.195	1.771	There is difference
	Control	15			

Table 3 shows that the pre-test score of the experimental class has a t-value of 0.988, while the t table of 1.771. In other words, if the t value is smaller than the t-table (0.988 < 1.771) then it means that Ho is accepted and H1 is rejected. So, there is no significant difference between the scores of science process skills obtained in the experimental class and the control class before treatment.

The post-test score in the experimental class obtained a calculated price of 2.195 with a t-table price of 1.771. The score indicates that the calculated t score is greater than the table t (2.195 > 1.771) so it can be concluded that H0 is rejected and H1 is accepted meaning that there is a significant difference between the scores of science process skills obtained in the experimental class and the control class after treatment.

The average score of the responses of the experimental class learners was 39.93 which belongs to the good/agree category. The overall percentage of student responses can be seen in Table 5.

Table 5. Percentage of Student Responses

Class	The average score of student responses	Criteria
Experiment	40.13	Positive
Control	33.80	Positive

The average response scores of students in Table 17 showed that the experimental class had a better response compared to the control class. The average score of student's responses in the experimental class was 40.13 which belonged to the positive category and in the control class was 33.80 which belonged to the positive category.

The learning that has been carried out at SMAN 11 Banjarmasin in the framework of this research is to implement a blended learning-based guided inquiry. The guided learning model is a model where students must be able to find answers to a question/problem but are still guided by the teacher. Guided inquiry is one of the inquiry approaches that presents problems, questions, and experimental procedures to solve problems. Problems and questions encourage students to conduct investigations to find answers. This learning activity is to collect data from problems already discovered by learners, make hypotheses, conduct investigations, analyze results, make conclusions, and communicate the results of investigations.

The methods that students must master are in the form of discussion, presentation, and experiment methods. The learning process in the developed learning model is contained in the components of the guided inquiry model. Characteristics of scientific activity in experiments with the task of science process skills specifically designed to improve the ability skills of the science process.

Science process skills are the ability of knowledge and and physical as well as the ability necessary to study science, solve problems, self-development of each individual through the process of observation or observation and experimentation to produce the desired information or conclusions. Science process skills have ten stages. Ngatijo et al. (2022) mention that in general the criteria for a person to have science process skills are observing, grouping, interpreting, predicting, asking questions, hypothesizing, planning experiments, using tools and materials, applying concepts, and communicating.

Student's SPS scored based on pre-test and post-test. The pre-test is used to find out the results of each initial SPS, then the two classes are given different treatments when entering the learning process. Post-tests are conducted in experimental and control classes when learning ends. The goal is to find out the effect of treatment for each class.

Before the data is analyzed using a t-test, the data is first tested for homogeneity and normality. Based on homogeneity and normality tests, it show that the data is distributed homogeneously and normally. Furthermore, to find out whether the guided inquiry learning model with a blended learning chassis has an effect or not on students' SPS, a hypothesis test was carried out. Hypothesis testing is carried out on pre-test and post-test data. The results of the pre-test hypothesis test showed that H0 was accepted, which means that between the experimental and control classes there was no difference in student SPS Based on the results of the hypothesis test, post-test data showed the rejection of H0 and acceptance of H1 It can be interpreted that there is a difference in the average SPS of students in experimental and control classes. This means that there is a blended learning-based guided inquiry learning model.

Research conducted by Fitriyani et al. (2017) explained that guided inquiry effectively improves the ability of student's science process skills as evidenced by an average of 80.3 with good criteria. In addition, Manggabarani et al. (2016) state that the average score of learners using a blended learning-based guided inquiry learning model is higher. The results of another study by Garrison et al. (2008) explained that the use of the blended learning process between guided and online inquiry provides a unique experience for students so that students can maximize their abilities.

Guided inquiry learning and science process skills have a relationship, where the stages of guided inquiry can support indicators of science process skills. The stage of presenting problems or questions can make students think about the guesses that may occur in the experiment to be carried out. Students try to relate illustrations and problem formulations to draw a temporary conjecture. The illustrations presented are often encountered in student's daily lives.

The second stage in the structured inquiry phase is to conduct experiments, in this case, the ability to think critically can have an effect in writing down the results of the experiment. At the data analysis stage, it will require students to have the ability to think critically to

connect the results of the experiment according to existing theories. This makes the ability to provide advanced explanations to students develop. At the conclusion stage, students can write down conclusions according to the experiments that have been carried out.

Chemical materials used in guided inquiry learning are based on blended learning colloid material, where the material can be implemented in practicum activities related to the scientific activity phase of the guided inquiry model so that science process skills can be trained. This is supported by the results of Birgili's research (2015) which states that it is necessary to have systematic, structured learning activities, transfer more roles to students, and context-oriented teaching modules/materials (surrounding environment, daily life) so that it will improve the ability of science process skills.

There are ten indicators of science process skills developed in this study, these indicators are based on indicators proposed by Rustaman (2005) and adapted to the concepts present in colloid material. The ten indicators are observing, grouping, interpreting, forecasting, formulating problems, stating hypotheses, planning experiments, conducting experiments, applying concepts, and communicating. The score of SPS indicators can be seen in Table 6.

Table 6. Student SPS Result per Indicator

Indicator	Experiment	Control
Observing	63.08	66.74
Classifying	90.41	79.26
Interpreting	79.90	56.31
Predicting	79.90	95.94
Formulating Problem	82.00	77.17
Stating Hypotheses	82.00	77.17
Planning Experiment	90.41	79.26
Conducting Experiment	77.79	56.31
Applying Concepts	92.51	62.57
Communicating	79.90	79.26

Table 6 shows that the experimental class has SPS scores that tend to be higher than the control class for all indicators, except for the observing and classifying indicators. All scores of the SPS indicator fall within the skilled to highly skilled categories. The lowest score of SPS is observing skill. The observing skill involves activities using the senses or sensory aids to gather information, and identify, and record facts or events as they are. Students generally struggle to distinguish between observation and interpretation (Sholahuddin et al., 2020). Strengthening this skill is essential as it is a fundamental skill that all students should possess. Guided inquiry serves as an effective means to train students' observing skills. These findings align with Rahman et al. (2017) research, indicating that grouping indicators have the highest percentage due to student training. Similarly, the indicators for planning experiments and applying concepts in experimental classes have also seen improvement.

Based on Table 6, it can be concluded that guided inquiry learning strategies, whether implemented independently or integrated with online learning, are capable of enhancing all students' science process skills. However, online learning proves to support the development of improved science process skills.

Research using a blended learning-based guided inquiry model was carried out online and students learned from home due to the COVID-19 pandemic situation. This research can be an alternative learning for educators to maximize the ability of students to understand a learning concept and encourage students to be more active during the learning process. Elfeky et al. (2020) also reported that the effectiveness of FC can be increased by utilizing advanced organizers through Management System Learning to develop students' integrated science process skills.

The implementation of blended learning models, such as the flipped classroom, enhanced students' literacy and equipped them with essential prior knowledge, fostering better readiness for learning and problem-solving tasks. Engaging in this approach not only sparked enthusiasm among students but also led to the acquisition of strong scientific literacy skills. Students became more self-reliant and actively engaged in the learning process (Monaghan-Geernaert, 2019). The flipped classroom proved to be effective in aiding students' mastery of knowledge and enhancing their capacity to independently solve problems (Enfield, 2013; Zhang et al., 2021).

Conclusion

Science process skills are very important because they can build knowledge and problem-solving abilities. The most important factor in the development of science process skills is inquiry skills. This research found that there are differences in the science process skills between students who learn using a blended learning-based guided inquiry model (experiment class) and a guided inquiry learning model only (control class). The students' SPS of the experimental class were better than the control class. Students also respond well to learning using a blended learning-based guided inquiry model on colloid material with positive categories. It is necessary to conduct further research by using better media so that it can increase student interaction and can repeat learning materials more, for example using Google Classroom, e-learning, and teacher's room. To implement blended learning, schools need to provide a

platform or media that can be used by all students and teachers. In addition, schools can also provide special WiFi so that students do not experience limited quotas during learning. Further research needs to address an improvement of observing skill which has still low. For example, by changing the students' worksheet, or the learning model used.

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Author Contributions
Iriani Bakti: conducting conceptualization of research variables, and designing research methodology and instruments. Reni Hafizah: conducting investigation, data curation, and data analysis. Arif Sholahuddin: conducting validation of data analysis, writing the original draft, and reviewing and editing the manuscript.

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Conflicts of Interest
No conflict interest.

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