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Exploring Inquiry Skills During Home Experiments about Science in the Online Instruction

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Exploring Inquiry Skills During Home Experiments about Science in the Online Instruction

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Abstract. Inquiry is an essential skill in science learning which includes designing, conducting, and interpreting the results of scientific investigations. Inquiry skills are usually taught by applying instruction by doing science-based education. Experiments are essential in training students' inquiry skills in science learning. Online science learning is effectively used to teach theoretical or conceptual material and becomes a challenge when applied in education that provides practical experience in the laboratory by involving experiments methods with hands-on exercises. This study tried online science learning by integrating experimental activities using hands-on activities carried out by students in their respective homes. During science lessons, students choose a topic about science and conduct experiments at home. Students design experiments, collect data, analyze data, and formulate conclusions to construct scientific knowledge. The results showed that practical activities carried out at home in online science learning could help students develop their inquiry skills. Students can carry out scientific investigations by applying various inquiry skills to obtain valid scientific knowledge.

1. Introduction

Science is a science consisting of processes, products, and scientific attitudes. The product of science is concerned with the principles, theories, and laws in science. The scientific process describes how science is discovered by involving a scientific attitude. Previous scientists carried out a series of investigative techniques involving inquiry skills in finding scientific products. In science learning, scientific inquiry is a skill that includes planning, implementing, and interpreting the results of scientific research/investigations [1]. Inquiry skills cover a variety of scientific process activities, including asking questions, designing experiments, collecting data, analyzing and interpreting data, and formulating conclusions [2-4]. The inquiry skills can be taught to students by applying a learning process based on active learning, learning by doing [5]. Students perform various activities both physically and mentally to construct mastery of science.

Active learning involves inquiry activities that can be implemented by applying laboratory-based science learning. Experimental and practical exercises in the laboratory provide many benefits for students when learning science. Besides developing students' knowledge of science, active understanding in the laboratory can also develop inquiry skills. Students can construct scientific knowledge through the stages of designing experiments, preparing tools and materials, collecting data and information, analyzing data, and formulating conclusions.

Science learning by involving science process activities can provide many benefits for students. When students carry out activities to formulate hypotheses, make observations, analyze data, interpret

findings, and draw conclusions, the initial knowledge possessed by students can have a significant influence on skill development [6]. When students engage in scientific investigations, they have applied thinking skills to understand data and relate observations to scientific theories [7]. Students use thinking skills in formulating appropriate conclusions with various data sources obtained [8]. Students who have been able to apply inquiry skills have carried out scientific activities and can construct scientific knowledge well.

Although inquiry skills provide many benefits for students, some students still have problems conducting investigations in science learning. Most students lack the strategy and knowledge to carry out scientific studies [9]. Scientific investigation activities that lack guidance from teachers can cause science learning to be less effective [10]. Some students also still have difficulties with inquiry skills and understanding of scientific inquiry [11-13]. For this reason, the development of inquiry skills must continue to be carried out in activity-based science learning by involving experimental activities. Experiments activities are an essential part of science that provide students with opportunities to develop skills [14].

In recent years, online science learning has been increasingly applied at the school and university levels [15], including in science learning. The learning paradigm shift affects the utilization of the science laboratory. Inquiry activities through practicum are carried out directly in traditional laboratories and are also carried out using online laboratories. Both types of laboratories have several advantages as well as some disadvantages. Although the online laboratory in the form of a virtual laboratory has several superior features, it does not provide opportunities for interaction between students and teachers [16]. Virtual laboratories cannot wholly replace physical experiments carried out in traditional laboratories [14]. Students stated that online learning was less able to facilitate students in developing their skills in technology and equipment [17]. On the other hand, traditional laboratories have the advantage of helping students develop practical and procedural skills [16] in science instruction.

For this reason, in this study, online science learning was tried by involving students in simple experimental activities that were carried out independently at home. Hollenbeck [18] suggests that inquiry learning strategies should still be implemented during distance learning by offering active student learning by providing relevant tasks with precise task completion times. Students must continue to acquire scientific knowledge and develop skills to transfer that knowledge to real-world problems [19]. Online learning by applying experiments at home like this is expected to facilitate students in developing inquiry skills.

2. Methods

The research was carried out by applying online learning using a learning management system (LMS) in science courses. The lecture material is about applying the scientific method in studying natural science. Synchronous learning is carried out for three weeks, 100 minutes per week. During synchronous learning, lecturers explain the material, ask questions about the material being studied, and students solve science problems. The discussion process is also carried out asynchronously by utilizing the discussion forum feature on the LMS.

Students are individually assigned to confirm their knowledge of the scientific method through experimental activities at home. Students are free to choose the topic of the experiment as long as they follow the guidelines for implementing the scientific strategy. If the experimental design has been mutually agreed upon, students can carry out the experimental stages at their respective homes. Students prepare tools and materials during practical activities, observe and measure variables, analyze data, and formulate conclusions. The process of experimenting must be recorded as a video and then uploaded to the LMS.

Participants were 37 students taking science courses 15 males and 22 females, aged between 20-21 years. Students come from 3 universities, namely the State University of Malang (UM), Ganesha University of Education (Undhiksa), and the University of Jember (UNEJ), participating in the student exchange program.

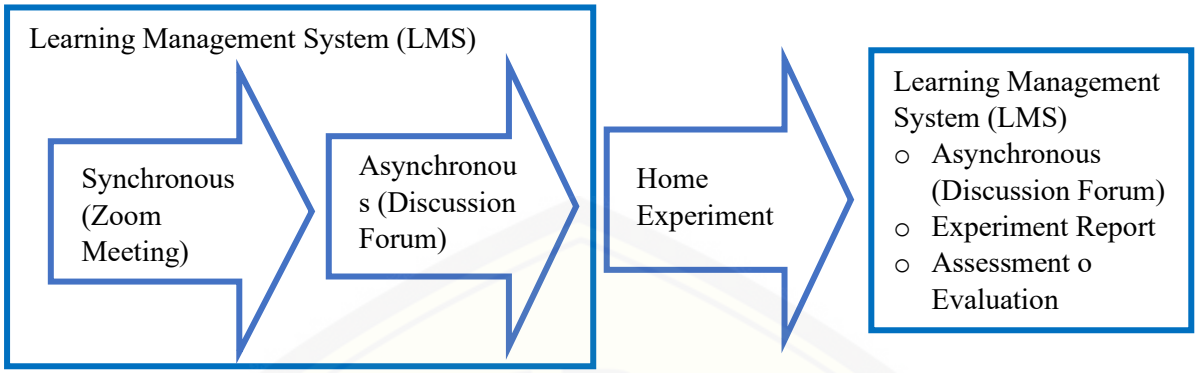

Figure 1. Learning stages

Inquiry skills are assessed based on practicum reports made by students. Aspects of inquiry skills assessed include: formulating problems, formulating hypotheses, designing experiments, recording data, creating graphs/diagrams, interpreting graphs/diagrams, and concluding. Each aspect is scored on a scale of 1 to 4. The total score of each student is converted to a score on a scale of 0-100. Descriptive statistical analysis was conducted to describe students' inquiry skills in solving problems through home experiment activities based on the score of inquiry skills.

3. Results and Discussion

3.1 Experiment Topic

Science learning is carried out for three weeks using LMS. The students carried out the experimental activities in their own homes. Students must choose the experiment topic and adapt it to the lecture's case, namely the scientific method of natural science. Based on the results of student discussions during learning synchronously and asynchronously, several experimental topics were agreed upon. Data on practical issues and the number of students for each subject are shown in Table 1.

Table 1. Experiment topic

Experiment topic	Number of Students
Plant growth	10
Light spectrum	2
Water absorption	5
Water purification	2
Rock weathering	4
Soil erosion	3
Changes in rock position	4
Water movement	2
Water pollution	2
Soil pollution	3
Total	**37**

Based on the data in Table 1, it can be seen that the experimental topics chosen by students are quite varied. The most chosen topic is plant growth. Two students chose four practical issues, namely the spectrum of light, water purification, water movement, and the solubility of substances. Many students chose the topic of plant growth because the subject was widely studied by students while studying science at school.

3.2 Inquiry Skills

Students conduct experiments at home according to the chosen topic. In experimental activities, students carry out several activities, including formulating problem formulations, formulating hypotheses, making experimental designs, collecting data, making graphs of relationships between variables, interpreting experimental results, and drawing conclusions. The results of all these activities are written in the practical report. Inquiry skills were assessed based on experimental reports using an assessment guide rubric. The score of inquiry skills and the score of skills in each aspect of inquiry is shown in Table 2.

Table 2. Inquiry skills

Data	Skills							
	Formulation of the problem	**Hypothesis of the problem**	**Design of Investigation**	**Make Record Data**	**Create Graph**	**Result Interpretation**	**Draw Conclusion**	**Inquiry Skills**
Number of Students	37	37	37	37	37	37	37	37
Score Maximum	4	4	4	4	4	4	3	93
Score Minimum	2	2	3	3	2	2	1	57
Average	3.57	3.26	3.72	3.15	3.28	2.70	2.47	80.40
Deviation standard	0.574	0.757	0.500	0.500	0.493	0.502	0.614	6.417

3.3 Experiment on Soil Erosion

One of the experimental topics conducted by the students was soil erosion. In this topic, three students conduct experiments. One form of his investigation was about the effect of water droplets on the size of the ground ball. Students changed the position of the height of the water droplets and measured their impact on changes in the size of the ground ball. The experimental data are shown in Table 3.

Table 3. The effect of a drop of water on the size of a soil ball

Experiment	High	Circumference of the Soil Ball
1	10 cm	13.8 cm
2	15 cm	13.1 cm
3	20 cm	12.6 cm
4	25 cm	11.2 cm
5	30 cm	10.1 cm

Based on the experimental data in Table 3, the difference in the height of the water drop causes a difference in the energy given to the water drop to the ground ball. The higher the water drop on the ground ball, the greater the energy provided by the water drop to the ground ball. This process causes the rate of erosion to accelerate.

3.4 Experiment on Changes in Rock Position

Another experimental topic is about changing the position of rocks. In this topic, four students experiment. One of the practical forms is about the effect of surface slope on the travel time of stones to reach the base plane. In this experiment, they were changing the angle of the inclined plane and measuring the travel time for rocks to get to the bottom. The process of removing stones from the top of an inclined plane is shown in Figure 2, and experimental data are shown in Table 4.

Figure 2. The stone is released from the height of the inclined plane

Table 4. Effect of the slope with travel time

Slope (°)	Travel Time (s)
100	1
110	1.2
120	1.5
130	1.8
140	1.9
150	2.1
160	2.8
170	2.9

Based on the experimental data in Table 4, the difference in the angle of inclination of the plane causes differences in the travel time of the stone to reach the bottom. The student inference that the greater the inclination angle, the shorter the stone's travel time. Based on these experiments, it can be concluded that the slope of the plane affects the speed of the stone roll. The greater the angle of inclination, the faster the stone rolls. Conversely, the smaller the inclination angle, the slower the stonerolls. The process of sliding stones on the plane often occurs when the stone experiences a shift in position.

4. Conclusion

In online learning, inquiry skills remain the main target of science learning. Based on the results ofthis study, it can be concluded that experimental activities carried out at home can be used as alternative activities for students to develop inquiry skills. Students can carry out practical exercises, including formulating problems, formulating hypotheses, designing experiments, collecting data, drawing graphs of relationships between variables, interpreting experimental results, and drawing conclusions. Thus, online learning is not an obstacle for teachers in developing science process skills. With a discussion process with peers and guidance from the teacher, students can design experiments, carry out investigations, and prepare experimental reports.

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