Implementation Management Strategies for Modern Physics Experiment with Online Systems Approach to Improve The Quality of Learning or Physics Students

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Abstract. Since COVID-19 broke out in early 2020, State University of Malang has implemented online lectures. This transformation creates new problems, including in Modern Physics experiment lectures. The fact is that when students was founded with the problem of assembling complex tools they are unable to implement their knowledge. The problems with Modern Physics experiment lectures that have existed for a long time are now exacerbated by the emergence of the COVID-19 pandemic. In overcoming this problem, the researcher implementation, management strategy with a systems approach as a solution with the consideration that this strategy is able to direct students to think critically. This study aims to improve students' practical understanding and learning quality. This research was conducted in 2 cycles. The research instruments were questionnaires and experiment reports. Based on the data analysis of the questionnaire cycles I and II, it was concluded that the quality of the implementation of modern physics experiment learning was good with an average result of 88.38%. In addition, there is an increase in students' practical understanding which can be seen from the average score of the experiment report, where the first cycle is 91.33 and the second cycle reaches 95.

1. Introduction
Currently, the discussion about COVID-19 (Corona Virus Disease 2019) is a hot topic in various countries. COVID-19 first appeared at the end of 2019, precisely in Wuhan, China [1]. COVID-19 is a disease caused by SARS-CoV-2 whose transmission is very fast and it is difficult to know the characteristics of people who have contracted this virus because the incubation period is approximately 14 days [2]. Almost all countries in the world have been affected by COVID-19, including Indonesia. COVID-19 has affected all aspects of life, including education [3]. Since WHO (World Health Organization) declared COVID-19 as a pandemic on March 11, 2020 [4], various policies have been issued by the Indonesian government, one of which is a policy in the field of education through the circular letter of the Minister of Education and Culture Number 15 of 2020 concerning "Guidelines for the Implementation of Learning From Home in an Emergency Period. The spread of COVID-19".

Such conditions make the State University of Malang implement an online lecture policy or online lectures. Online learning is an educational innovation that involves elements of information technology in learning [5]. Therefore, many application facilities are available on telecommunication tools to facilitate interaction between lecturers and students [6]. Lectures that were originally offline must be transformed into online, this transition process requires every educator to apply a new
learning model [7], especially in the Modern Physics experiment course. Modern Physics experiment course is a compulsory subject for Physics Education Study Program students. In the experiment, this experiment is separate from the activities of Modern Physics theory. The implementation of the Modern Physics experiment usually begins with the introduction of both passive and active components, then students observe the characteristics of the components by following the experiment instructions.

However, in fact, in the Modern Physics experiment, there are weaknesses, among others, when faced with the problem of assembling complex tools they are not able to implement knowledge about the characteristics of each component in understanding complex circuits. Sometimes experiment activities are only seen as formalities that must be met to be able to take Modern Physics experiment courses. Realizing this reality, the author tries to examine the implementation of the Modern Physics experiment by paying attention to the following 3 things: (1) experiment by studying the characteristics of each component separately does not stimulate students' thinking and creativity; (2) practical students feel that understanding the characteristics of the components of modern physics experiment has not become a necessity for them; (3) the acquisition of experiment scores has not been meaningful for students, it can be seen from the inability to implement their knowledge on other problems.

To find alternative solutions to problems, a series of discussions have been carried out by the supervisor of the modern physics experiment course, especially regarding the low effectiveness of this experiment activity. The conclusion of this discussion recommends an experiment management strategy using a systems approach, where from the beginning students are introduced to a complete system composed of components of online experiment learning implementation. The basic consideration, with this strategy from the beginning, students have been directed to think critically about how the system works and how the contribution of each component of the learning participants in the system. In the end, the students' curiosity about the working of systems will motivate them to know more about the characteristics of the components of modern physics. Student creativity can also be built by questioning the possibility of developing an existing system [8]. Practical learning with a systems approach in question is learning the strategy for managing experiment activities which consist of three stages, namely (1) the preparation stage; (2) the exploration stage; (3) the application stage [9].

Considerations that Another is in assigning modern physics experiment tools and materials cannot be provided outside the modern physics laboratory because the tools and materials are special and expensive. Therefore, the use of the online system needs to be optimized in carrying out quality and effective modern Physics experiment learning, therefore this research takes the title "Implementation Management Strategies for Modern Physics Experiment with Online Systems Approach to Improve the Quality of Learning for Physics Students" which aims to apply Modern Physics experiment management strategies with a systems approach to improve understanding of concepts for students participating in Modern Physics experiment courses through online learning.

2. Method
This type of research is classroom action research called classroom action research, which is a systematic study of classroom learning experiments to improve or improve the quality of the learning process and results carried out by certain actions [10]. Suharsimi Arikunto (2002) stated that classroom action research is practical research, because classroom action research is carried out to solve factual problems that are faced by teachers as managers of learning activities [11]. This research departs from the problems that exist in the field and then is reflected and analyzed based on the theory that supports the implemented action.

This classroom action research was conducted by the Department of Physics, Faculty of Mathematics and Natural Sciences, State University of Malang Jl. Semarang No. 5 Malang. This research involves students of the physics education study program, a lecturer in charge of experiment courses, and a student who is taking a Modern Physics experiment course in the even semester of 2020-2021. This research was carried out in 2 cycles. Based on the initial evaluation, discussion, and lecturer's reflection on the performance of previous lectures, the action given in the first cycle is the
approach of enforcing the implementation strategy of the Modern Physics Experiment. With a systems approach to students participating in the Modern Physics Experiment course.

In more detail, the procedure for this classroom action research is as follows: (1) planning the first cycle, at this stage preparing the 1st and 2nd experiment videos, uploading the 1st and 2nd experiment videos to the student via the HTTPS link, carrying out the experiment by downloading the videos on the sipejar 1st and 2nd experiments. Within one week, students explore by making a report that is uploaded to the student. To evaluate the students conducted a discussion of the results of the experiment report via zoom. Reflecting on the results of the implementation of cycle 1, to plan cycle 2; (2) action planning cycle 2, at this stage preparing the 3rd and 4th experiment videos, uploading the 3rd and 4th experiment videos to the student via the HTTPS link, carrying out the experiment by downloading the 3rd and 4th experiment videos on the student. Within one week, students explore by making a report that is uploaded to sipejar. To evaluate the students conducted a discussion of the results of the experiment report via zoom. Reflect and analyze the results of the implementation of cycle 2 to obtain conclusions. In this study, the instrument was used in the form of questionnaire results in cycle 1 and cycle 2 and an experiment report. In analyzing the data, RPS is needed for the Modern Physics experiment course. In the Modern Physics experiment, the implementation is based on the description of the Modern Physics experiment course. For learning devices, they were analyzed qualitatively, while for research data, such as experiment reports in cycle 1 and cycle 2, the average class score was then compared whether there was an increase in learning scores and to measure the quality of learning referring to the Arikunto classification (2002) used the average questionnaire in the cycle. 1 and 2.

| Criteria for assessment score (%) implementation of learning. | Score (%) |
|---------------------------------------------------------------|-----------|
| Very good                                                    | 92-100    |
| Good                                                         | 75-91     |
| Pretty good                                                  | 50-74     |
| Ugly                                                        | 25-49     |
| Bad                                                          | 00-24     |

3. Results and Discussion
Based on the questionnaire data analysis conducted by researchers in the implementation of the first cycle activities are as follows:

(1) The use of experiment videos as learning media for modern physics experiment courses has produced symptoms that are following the theory in the practical determination of electron-specific charge and Michelson interferometer experiment. This is known from the results of the first cycle of the questionnaire regarding the suitability of the experiment video with symptoms in theory.

Table 1. The results of the questionnaire regarding the suitability of the video with theory.

| Experiment                                      | Agree  | Disagree |
|-------------------------------------------------|--------|----------|
| Determination of the specific charge of electrons| 93.1%  | 6.9%     |
| Michelson interferometer experiment             | 95.6%  | 4.4%     |

(2) The use of experiment videos as a learning medium for modern physics experiment, subjects makes students free to take data in the experiment of determining the specific charge of electrons and Michelson interferometer experiment. This is known from the results of the first cycle of the questionnaire regarding the freedom of students in obtaining data through experiment videos.
Table 3. The results of the questionnaire regarding the freedom to obtain data.

| Experiment                          | Agree | Disagree |
|-------------------------------------|-------|----------|
| Determination of the specific charge of electrons | 86.3% | 13.7%    |
| Michelson interferometer experiment | 90%   | 10%      |

(3) The use of experiment videos as a learning medium for modern physics experiment, subjects makes students take data on the dependent variable according to the measured symptoms in the experiment of determining the specific charge of electrons and Michelson interferometer experiment. This is known from the results of the first cycle of questionnaires regarding the suitability of data collection for the dependent variable with the measured symptoms through experiment videos.

Table 4. The results of the questionnaire regarding the suitability of the data and symptoms.

| Experiment                          | Agree | Disagree |
|-------------------------------------|-------|----------|
| Determination of the specific charge of electrons | 90.8% | 9.2%     |
| Michelson interferometer experiment | 90%   | 10%      |

(4) The use of experiment videos as a learning medium for modern physics experiment courses presents measurements with good video quality where the scale is clear to the smallest scale in the experiment of determining the specific charge of electrons and Michelson interferometer experiment. This is known from the results of the first cycle of the questionnaire regarding the clarity of the measurement scale to the smallest scale through experiment videos.

Table 5. Questionnaire results regarding the clarity of the measurement scale.

| Experiment                          | Agree | Disagree |
|-------------------------------------|-------|----------|
| Determination of the specific charge of electrons | 77%   | 23%      |
| Michelson interferometer experiment | 73.3% | 26.7%    |

(5) The use of experiment videos as a learning medium for modern physics experiment courses can increase student creations in developing material in the experiment of determining the specific charge of electrons and Michelson interferometer experiment. This is known from the results of the first cycle of questionnaires regarding the effect of experiment videos on the level of student creation in concluding and developing material.

Table 6. Questionnaire results regarding human creations in concluding material.

| Experiment                          | Agree | Disagree |
|-------------------------------------|-------|----------|
| Determination of the specific charge of electrons | 92%   | 8%       |
| Michelson interferometer experiment | 88.9% | 11.1%    |

From the average result obtained in the first cycle, the researcher carried out the second cycle to correct the deficiencies in the first cycle. The following are the results of the second cycle of questionnaire data analysis:
(1) The use of experiment videos as a medium of learning for modern physics experiment courses has produced symptoms that match the theory in Franck Hertz’s experiment and nuclear radiation count. This is known from the results of the second cycle of the questionnaire regarding the suitability of the experiment video with the symptoms in theory.

Table 7. Questionnaire results regarding the suitability of the video with theory

| Experiment                  | Agree       | Disagree   |
|-----------------------------|-------------|------------|
| Franck Hertz’s Experiment   | 94.3%       | 5.7%       |
| Nuclear radiation count     | 92.2%       | 7.8%       |

(2) The use of experiment videos as a learning medium for Franck Hertz's experiment and nuclear radiation count make students free to take data in the experiment. This is known from the results of the second cycle of questionnaires regarding the freedom of students in obtaining data through experiment videos.

Table 8. The results of the questionnaire regarding the freedom to obtain data.

| Experiment                  | Agree       | Disagree   |
|-----------------------------|-------------|------------|
| Franck Hertz’s Experiment   | 87.4%       | 12.6%      |
| Nuclear radiation count     | 83.4%       | 16.6%      |

(3) The use of experiment videos as a learning medium for modern physics experiment subjects makes students take dependent variable data according to the symptoms measured in the Franck Hertz’s experiment and nuclear radiation count. This is known from the results of the second cycle of questionnaires regarding the suitability of data collection for the dependent variable with the measured symptoms through experiment videos.

Table 9. The results of the questionnaire regarding the clarity of the measurement scale.

| Experiment                  | Agree       | Disagree   |
|-----------------------------|-------------|------------|
| Franck Hertz’s Experiment   | 89.7%       | 10.3%      |
| Nuclear radiation count     | 94.5%       | 5.5%       |

(4) The use of experiment video as a learning medium for modern physics experiment courses presents measurements with good video quality where the scale is clear to the smallest scale in the Franck Hertz’s experiment and nuclear radiation count. This is known from the results of the second cycle of the questionnaire regarding the clarity of the measurement scale to the smallest scale through experiment videos.
(5) The use of experiment videos as a medium of learning for modern physics experiment courses can increase students' creativity in developing material in Franck Hertz’s experiment. This is known from the results of the second cycle of questionnaires regarding the effect of experiment videos on the level of student creation in concluding and developing material.

**Table 10.** The results of the questionnaire regarding the suitability of the data and symptoms.

| Experiment                  | Agree | Disagree |
|-----------------------------|-------|----------|
| Franck Hertz’s Experiment   | 81.6% | 18.4%    |
| Nuclear radiation count     | 92.2% | 7.8%     |

**Table 11.** Questionnaire results regarding human creations in concluding material.

| Experiment                  | Agree | Disagree |
|-----------------------------|-------|----------|
| Franck Hertz’s Experiment   | 92%   | 8%       |
| Nuclear radiation count     | 93.3% | 6.7%     |

Based on the results in a cycle I and cycle II, the average of each cycle is presented in the following diagram:

![Figure 1](image)

**Figure 1.** The average results of the first cycle of the questionnaire and the second cycle.

To find out the understanding of the concepts of students participating in the Modern Physics experiment course through online learning, the researchers reviewed the results of the student experiment reports. The following is the data from the student experiment report:

**Table 12. The average value of student experiment reports.**

| Offering | Load determination electron specific | Michelson interferometer experiment | Franck Hertz’s Experiment | Nuclear radiation count |
|----------|--------------------------------------|-------------------------------------|--------------------------|-------------------------|
| AC       | 90.38                                | 89.38                               | 93.75                    | 95.13                   |
| B        | 91.79                                | 93.75                               | 94.6                     | 95.4                    |

Based on the average value of student experiment reports in the cycle I and cycle II, the following diagram is obtained:
4. Conclusion
The quality of the implementation of modern physics experiment lessons using experiment videos can be seen from the results of the distribution of research instruments, namely questionnaires. In the first cycle, the quality of the implementation of learning that is included in the good criteria and has reached the expected criteria, it can be seen from the average quality of the implementation of learning through experiment videos in the first cycle reaching 86.7%. In the implementation of the second cycle of learning reached 90.06%. So the average cycle I and cycle II are 88.38% and is in the good category. So it can be concluded that the quality of the learning implementation of modern physics experiment courses using experiment videos is good.

Improved understanding of the concept of practicing modern physics can be seen from the value of student experiment reports. A good experiment report score was obtained in both cycles. In the first cycle, the students' understanding of practical concepts was included in good criteria and had reached the expected criteria, it was seen from the average student experiment report score of 91.3. Understanding the concept of the experiment in cycle II obtained an increase in achievement to 95 and is in very good criteria. This increase occurs because students have been able to take data and their errors well, are able to explain phenomena that occur in the experiment, and develop material through independent observations made by the student.

This online learning method is recommended to use modern physics experiment videos as an alternative to other physics experiment.

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