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Learning Problems of Prospective Teachers in Lectures Modern Physics During the Covid-19 Pandemic

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Abstract.
Since the COVID-19 pandemic hit the world, many problems have been caused by accompanying effects, including impacts in the field of education. This study aims to explore the problems faced by physics education study program students in modern physics lectures in online learning during the COVID-19 pandemic. The method used in this study is a qualitative description with a questionnaire as a data collection technique. A total of 28 students who contracted modern physics courses and two lecturers who taught modern physics courses were participants in this study. The collected data were analyzed descriptively-qualitatively. After data analysis, several problems faced by students in attending modern physics lectures can be identified, namely: difficulty mastering concepts, internet signal interference, less interesting/monotonous learning, and never doing modern physics practicum. Limited tools are the main factor in the inability to carry out practicum. Even though practicum allows students to master abstract concepts of modern physics. Based on these findings, further research can be carried out that can facilitate students to more easily master modern physics concepts that are integrated with a practicum in the learning process.

Keywords: learning problems, prospective teachers, lectures modern physics, covid-19 pandemic

1. INTRODUCTION

Online work is no longer a unique social or professional reality, both internationally and locally, as interpersonal engagement is possible in ways other than just face-to-face meetings Conventional. As a result, many activities are facilitated by online conferences. especially after 2007 (for Lynk), 2011 (for Zoom), 2013 (for Skype Business), and 2017 (for

Microsoft Teams). However, due to the conditions of the COVID-19 pandemic, there has been a sharp increase in professional activities carried out online or through different online platforms [1, 2]. The COVID-19 epidemic has resulted in a tremendous increase in the number of users that will use e-learning tools [3]. As a result, there has been an increase in online engagement in education which adds to the workload for both teachers and students.

Higher education institutions have also been impacted by COVID-19 shutdowns. Universities began offering online courses (Boehringer, 2018). Some universities have the necessary tools and trained employees to provide online instruction [4, 5]. In some places in the world, faculty do not have the necessary training to offer online instruction. In addition, some university programs may not benefit from switching to an online format. Because it requires face-to-face interaction with teaching staff to manage the practical components of the course. However, it is mandatory to learn using online platforms because all educational facilities are closed due to the COVID-19 pandemic [6]. The transition was forced to be carried out even though it was not supported by adequate facilities. The psychology of students becomes sudden shock by learning online using makeshift facilities and is not yet familiar among them [3, 7]. Including the learning of modern physics which is abstract and difficult.

Modern physics as part of the compulsory courses that must be taken by prospective teachers, is not only developed in terms of content. However, it is necessary to pay attention to the procedures for delivering the content in the learning process to achieve certain skills. The beginning of the emergence of modern physics when the magnificent buildings of classical physics began to collapse around the end of the 19th century [8]. The content of modern concepts is classified as abstract and microscopic [8, 9], and can be felt but cannot be seen. Since the beginning of the 20th century modern physics has experienced very rapid development, until now the development of modern physics content continues to be enriched through studies such as Compton scattering, electron scattering, and electron momentum [10, 11], wave packet scattering [12], electron diffraction [13], electron temperature and bremsstrahlung [14], Zeeman effect [15], and the nonlinear Schrödinger equation [16]. Most of this research is carried out oleh scientists in developing the content of physical sciences.

The development of modern physics content through research continues to be carried out. The transformation of theory from research results needs to be simplified as a learning subject. Modern physics is not only known for being abstract and microscopic but also known for complex calculations [9, 17]. Therefore, a learning approach that is suitable for the subject of study is needed. In recent years, the learning paradigm has shifted from the teacher as the center of learning to the student as the center of learning [18–20]. This paradigm shift is because the old paradigm is considered no longer relevant to the times. The rapid flow of globalization demands various life skills of the 21st century. So, the current learning orientation must be adjusted, namely by practicing 21st-century skills [21]. Among the emphasized 21st-century skills such as learning and innovation skills, Technology Skills and media literacy, critical thinking, and problem-solving skills [22–24] Such life skills are necessary to overcome possible problems that arise in life.

In modern physics learning practice, sometimes students assume that the topics studied seem unrelated to the real world. This assumption is based on the absence of real material studied as an object during the learning process [17, 25, 26] To eliminate this assumption, it must be known more deeply the real problems faced by students when learning. The problems experienced are not only present by students but also by outside students. By knowing student learning problems more deeply, it will be easier to offer solutions to these problems.

Studies on modern physics have been widely conducted. However, most of these studies only focus on developing scientific content [10, 11, 27] While research related to the learning process of modern physics, the difficulties faced while learning, and factors that affect learning outcomes are still rarely carried out. Thus, there needs to be a special review related to the learning process of modern physics and its problems, as a means of finding sources of student learning problems. Based on the description above, the purpose of this research is to identify the problems faced by physics education study program students in modern physics lectures during online learning during the COVID-19 pandemic.

2. RESEARCH METHOD

The study includes qualitative research, qualitative research allows to obtain data on the experience of the subject experienced in his life [28, 29]. This qualitative research uses a cross-sectional survey. Cross-sectional surveys are very well used to measure opinions, opinions, or inner moods according to the conditions felt by the subject at that time [28]. This research was conducted during the COVID-19 pandemic, so data collection was carried out using questionnaires with open-answer options. The questionnaire was distributed through a Google form targeting prospective physics teachers who were contracting modern physics lectures. A total of 28 prospective teacher students were willing to send responses from two universities in West Nusa Tenggara that had been determined. The collected data is analyzed descriptively. A total of 6 statement items were given to participants, the statements can be seen in Table 1.

Table 1: Questionnaire on the experience of prospective physics teachers following modern physics lectures.

No	Question
1	How interesting is the study of modern physics to you?
2	What media do lecturers use in teaching modern physics topics?
3	How difficult is modern physics for you and what are the main obstacles faced when attending modern physics courses?
4	Have you ever done practicum during modern physics lectures and what are the obstacles if modern physics practicum has never been carried out?
5	How important is modern physics practicum in supporting your understanding of modern physics concepts?
6	In your opinion, what should modern physics learning be like?

Students are given freedom in responding to questionnaires, there is no limit to the length of responses. Coding techniques are used to process each respondent's response. Codes are only given to respondents to identify and simplify the response analysis process. There were 28 students and two modern physics lecturers who were respondents to this study. The respondents came from two universities in the West Nusa Tenggara region that were contracting modern physics lectures. Coding or labels are distinguished from the origin of universities, for example, R1A is the first respondent from college A. Then the label R1B is the first respondent from college B, and so on. While the lecturer labels are RDA and RDB, RDA refers to lecturers from College A and RDB refers to lecturers from College B. Data analysis is carried out by descriptive-qualitative, which describes the responses given by respondents in the form of narrative sentences.

3. RESULT AND DISCUSSION

Research has been conducted on students related to the experience of attending modern physics lectures. This section describes analytically the response of students. Not all responses were included in the study, but only a few were thought to represent overall response. The following outlines responses ranging from questions 1 to 6.

3.1. Question 1: How interesting is learning modern physics to you?

Regarding the first question, students gave mixed responses, most of them gave responses in the form of statements such as: very interesting, interesting, quite interesting, and very uninteresting. After calculating the responses, the following percentages were obtained: 25% stated "very interesting", 18% stated "interesting", 54% stated "quite interesting", and 4% stated "very unattractive". The variety of student responses regarding interest in attending modern physics lectures is caused by various factors. Such as the level of abstractness and complexity of the material, student learning motivation, methods and media used, and even teaching staff factors [30, 31]. R8A states: *Modern physics requires a high level of reasoning because all objects of study are invisible*. Besides abstract, it also requires continuous analytical skills, because the complexity of the material is high. This condition will be worse if the teaching staff has no experience and only uses conventional methods.

Based on the calculation results, 25% and 18% of respondents fall into the category stating that learning modern physics is interesting to follow. If you look carefully, the development of science and technology cannot be separated from the contribution of modern physics [32, 33]. This possibility is what causes students to enthusiastically attend modern physics lectures. Next, 54% of respondents stated that it was quite interesting to attend modern physics lectures. More than half of the respondents gave such a statement, meaning that respondents were in a state of hesitation about attending modern physics lectures. This statement is considered not too firm because it is a neutral choice. But if examined further, most respondents who give statements like this are more likely to be disinterested in attending modern physics lectures. As R2B stated: *Learning modern physics is not just as exciting as I imagined, let alone online, face-to-face alone does not necessarily understand the concept*. There are many obstacles in online learning, so you need media that can cover these obstacles, such as computer simulation media. Based on this statement, learning using conventional methods is no longer relevant in the COVID-19 pandemic situation [34]. It takes innovation to facilitate all student learning needs.

The ability of lecturers to connect material content with the real world is one of the learning innovations, to bridge the level of abstractness of concepts that are too high. Maybe the learning method does not contribute to student interest in attending modern physics lectures. But classroom management is at least enough to support success in learning. R3B states that: *Modern physics is very closely related to current technological developments. But sometimes we are not able to connect the theory studied with the applications in the technology.* Therefore, in conditions like this, the role of lecturers must be maximized as facilitators to bridge the gap that occurs [35]. Finally, 4% of respondents said they were not very interested in attending modern physics lectures. After being traced, it turned out that the respondent reasoned: Modern physics material is difficult, and the lecturer explained it well. The Internet network in his hometown is very unstable. Making the learning process he participated in was never normal, even just the assignments he obtained, it was also based on information from his classmates. How dependent students are on the stability of internet signals in learning during the Covid-19 pandemic. It could be that a better impression will be expressed if the learning conditions in the situation are normal.

3.2. Question 2: What media do lecturers use in teaching topics in modern physics?

Media is one of the important components in the learning process. The selection and use of media can affect student learning concentration. During the COVID-19 pandemic, the role of the media has become very important in facilitating the learning process [36]. Learning media is not only limited to knowledge transfer aids. But further than that, it must be able to help the development of students' 21st-century skills [37]. Moreover, the learning process was carried out online during the Covid-19 pandemic. To question 2, student responses were no less diverse. The responses were like using Google Meet, WhatsApp, PPT, what pad, zoom, Phet application, Audiovisual, MFI, and Whiteboard.

The variety of responses given shows the variety of learning experiences experienced by students. An understanding of the understanding of learning media also colors the variety of responses. Learning media are tools or materials used to help stimulate students' thoughts, feelings, abilities, and attention in the learning process [38, 39]. The media can be in the form of tools or teaching materials. R10B states: *Learning media can help in understanding lesson content. During the current pandemic, learning media should be designed flexibly, namely utilizing computer networks/simulation media. So it can be played anytime and anywhere.* Learning media should be designed to keep up with the times. The limited ability to design ideal learning media is the main reason for the difficulty of making quality media.

On the other hand, the development of information technology today can be used to make learning media more varied and flexible. Moreover, the presence of artificial intelligence is one of the fruits of the development of science and technology [40, 41]. So that artificial intelligence can be embedded in the learning media created. The existence of artificial intelligence will add value to the usefulness of the media [42, 43]. R12B states: *The development of science and technology today, allows students to access various learning media available in cyberspace. Some of these media are relevant and some are not relevant to needs. But at the very least, existing media can* *help enlighten the topic being studied*. The capacity of students in surfing in cyberspace will determine the results of media searches that suit their needs. Therefore, students should not be allergic to the touch of current technological developments.

3.3. Question 3: How difficult is modern physics for you and what are the main obstacles you face when attending modern physics lectures?

This question is not an open secret for students of the physics education study program, considering the complexity of the material contained in it. Responses are given in the form of short statements, such as: "very difficult", "difficult", "quite difficult", and "not difficult". After calculations, 14% stated very difficult, 36% stated difficult, 39% stated quite difficult, 4% stated not difficult, and 7% stated very not difficult. This response is certainly based on the ability of each student. Most students, 89%, said they ranged from "very difficult to quite difficult". Only a few stated "not difficult" and "very not difficult". This means that the content of modern physics is still considered difficult by most students.

The degree of difficulty of a concept depends on the complexity of the content of the concept. It has been stated before that modern physics contains microscopic charges and high levels of abstractness [9, 44]. Thus, more optimal effort is needed to digest the content in it. Some of the content of modern physics that become studied in the learning process are special relativity, particle properties of light, atomic structure, wave properties of matter, introduction to quantum mechanics, Schrödinger equations for three dimensions, multi-electron atoms, molecular structure, nuclear structure, nuclear reactions, introduction to statistical mechanics, and introduction to solids. These contents have high complexity.

However, as many as 11% of respondents said modern physics is not difficult. This means that there are students the experience of attending modern physics lectures do not experience significant obstacles to understanding the content. However, this condition is only a small percentage of respondents. So that does not dispel the impression that modern physics is difficult. R5A states: The content of physics modern is a series of other subject content such as basic physics and mathematical physics. If you have a strong understanding of these two courses, it will help in understanding the content of modern physics. There is a content hierarchy relationship between modern physics and previous subjects, which are called prerequisite courses [8, 21]. Examples of prerequisite courses for modern physics are basic physics and mathematical physics.

Students have contracted and passed basic physics and mathematical physics courses before contracting modern physics courses. Thus, it is hoped that students will not experience too much difficulty when attending modern physics lectures.

Unlike R5A, respondents with the label R1A gave a statement: *even though they have taken and passed* prerequisite *courses, they still experience problems in understanding the content of modern physics. This is more due to the online learning carried out. Online learning makes the space for interaction between students and lecturers very limited. So, it is not optimal to explore content studies together if you experience difficulties. Not only limited interaction but also sometimes signal fluctuations greatly determine the continuity of the learning process.* The obstacles to using the online system are felt by all parties, not only in the learning process but also in other virtual meetings [4, 45, 46]. The infrastructure to support virtual activities is not perfect, because it was forced to move from offline to online in a short time due to the impact of COVID-19.

3.4. Question 4: Have you ever done practicum during your physics lectures? What are the constraints of modern physics practicum has never been implemented?

Regarding modern physics practicum activities, 29% of respondents stated that they had done practicum and 71% of respondents stated that they had never done practicum. It is well known that laboratory activity for physics is two sides of a coin that cannot be separated. But most students claim to have never done a modern physics practicum. After being traced, 50% of respondents said that due to covid 19 conditions, practicum could not be carried out. Practicum can be carried out, even though learning is carried out remotely [5, 47]. The availability of existing simulation media can be used to replace real practicums that cannot be held due to covid 19 [48, 49]. Likewise, with the sophistication of today's technology, teaching staff can create their simulation media or collaborate with other parties. Another reason that causes the non-implementation of modern physics practicum is that it is not planned, there are no tools, there are no modern physics practicum courses, and there are no suitable practicum media.

The reason that practicum was never planned correlates with the absence of available tools, so it has implications for the absence of special courses in modern physics practicum. This reason is rational and implies that the university hosting the study program cannot facilitate the provision of advanced physics laboratory equipment. The last reason, namely from R1B states: *Dense and many materials take a long time to learn and maybe the learning media for modern physics practicum is not suitable or* *exists*. This statement problem can be overcome by creating your own or developing an existing virtual laboratory. As found on the page https://phet.colorado.edu/, There are various simulation tigers available from the basic level to the high level. Respondents who stated that they had done practicum relied on their statements on simulation media available on this page. Not all topics of modern physics are in the simulations provided https://phet.colorado.edu/, But at least there is a reference if you want to do a virtual laboratory-based modern physics practicum.

3.5. Question 5: How important is modern physics practicum in supporting understanding are you against the concepts of modern physics?

The development of physics content is inseparable from experiments that have been carried out by scientists. Modern physics content is no exception, the development of modern physics content began rapidly in the early 20th century. Many scientists concentrate on conducting experiments according to their respective fields [10–12]. Respondents' responses to this question were not very diverse, meaning that they were very homogeneous and indicated the character of scientific thinking. Only 4% of all respondents stated that modern physics practicum is not important, the remaining 96% stated very important. Even during the pandemic, students still hope that there will be a modern physics practicum simulation to strengthen their reasoning power. As stated by R12A: *Modern physics practicum is important to support understanding even if only in the form of simulations*. This statement is relevant to the conditions at that time which were not possible to do practicum directly. Because all learning facilities are not accessible.

In the context of learning, the practicum carried out is still in a clarification order. However, at least with simulations, students can be helped to construct reasoning that was previously very abstract [50]. R1B states: *According to me, by carrying out practicum, theories or concepts that are only shadowed in the head can be transformed in the form of practicum so that the understanding of the concept becomes strong and deep-rooted. Likewise, the statement conveyed by R12B: Practicum is very important because we cannot necessarily imagine the microscopic world, at least there are parables or shadows in the practicum. So, the understanding of the material will be more sticky and good.*

Modern physics practicum is not only limited to clarifying the theory studied. But it goes further, it stimulates students to connect their study theory with applications in the field of technology [51]. R4A states: *Modern physics practicum is very important because in modern physics it cannot be separated from the surrounding phenomena and techniques for solving problems through physics, but also so that we know the use of modern physics itself.* The concept of modern physics is developing rapidly because it is largely supported by intense experiments [33]. This is how students should do learning, namely imitating scientists in finding ideas in every theory they give birth to. If it is far from reality, at least through practicum means it can reduce the level of abstractness of a concept or can strengthen the content of the theory that student's study. As stated by R3B: *I think modern physics practicum is very important because by practicing something, students will understand better after being given enough theory.*

3.6. Question 6: What do you think modern physics learning should be like implemented?

Ideally, the learning process is carried out by considering the rights of students. All activities are returned to student activities to acquire knowledge in their way [18, 52]. The learning paradigm has shifted from the teacher being the only center of learning to the student as the center of learning [53]. This paradigm shift indicates how important it is for student activities to construct their knowledge based on learning experiences. R4A gave its statement: *Learning modern physics should be through organized meetings because modern physics is not enough to just read the material, there needs to be active communication from both parties.* Two-way communication between students and lecturers is very important in the learning process [54][19] . But of course, the portion of students must be more so that they can boost their potential.

Learning science should meet the rules of the scientific method so that students are accustomed to methodological thinking. The habit of methodological thinking does not come spontaneously, but it needs practice from the beginning step by step [55]. Therefore, it is ideal if the habit of scientific thinking is practiced from elementary school. This is also relevant to the new paradigm of education, which is to provide the widest possible opportunity for students to develop their potential because it is the center of learning. R1B states: *Learning modern physics should be done in simple or easy, fun, and fun ways. Complicated concepts are given as much as possible simple and contextual analogies in everyday life so that they are more acceptable to the minds of all.* This habit of methodological thinking will be the capital to develop critical, creative, innovative thinking skills and so on.

During the COVID-19 pandemic at that time, face-to-face learning was not possible. But that does not mean the substance of the learning process is not carried out. A direct practicum that should be carried out can be replaced with computer simulations because physics cannot be separated from laboratory activities [56]. R12A states: *Lecturers should use illustration media.* Learning media in the form of illustrations or whatever the name is, can help students to stimulate reasoning. Provide clarity on concepts that are too abstract and can minimize misconceptions [57]. As a tool, learning media has been proven to contribute to mastering the concept of a study topic [58]. In abstract study topics, media illustrations can clarify the hierarchy of one variable with another. Learning media can be associated with practicum tools, as an integral part of the learning process. Especially in the subject of science, practicum activities are like two sides of a coin that are always side by side. R10B provides a statement: *Preferably, modern physic learning can be carried out with direct practicum and directly explained by the supervisor regarding the material practiced.*

The science framework cannot be separated from inquiry activities, which contain discovery inquiry, inquiry demonstration, inquiry lesson, inquiry lab, and hypothetical inquiry [59, 60] This way of working has been done by scientists in discovering new concepts or enriching previous concepts. These kinds of activities will have an impact on thinking habits. This habit of thinking is expected to bring changes to one's attitude and behavior. The emphasis on mastering 21st-century life skills has indeed been exemplified and carried out by previous scientists. However, in the process of learning practices need to be reconstructed, as a framework in school education.

Questions were not only given to student respondents but also to lecturers who teach modern physics courses. When lecturers are asked the question, *what are the main obstacles for you in learning modern physics?* RDB gave a statement: *Concretizing abstract modern physics material and students' basic mathematical abilities that are not yet qualified.* As previously described, modern physics course has prerequisites to be able to contract it. Learning success will be experienced by students when the prerequisites set are not or less met. This is where the relationship between courses lies with each other[9]. However, these obstacles will be overcome if students can construct or reorient the knowledge that has been obtained before. Not only do students have difficulty reasoning abstract concepts, but it turns out that lecturers also have difficulty concretizing concepts that are too abstract in the learning process. In conditions like this, the role of practicum/learning media is needed as a medium to reduce the level of abstractness of a concept.

The difficulty of lecturers managing a learning process that is too abstract will certainly have an impact on mastering student concepts. The existing learning media may not be very relevant related to the topic of study and not so strong to reduce the level of abstractness of concepts. So lecturers have to find other ways as alternatives to existing media, for example, making their simulations. But of course, it is not easy, because it relates to the competence of high-level computer operations. While not all modern physics lecturers have this ability. Therefore, it can be done in collaboration with other people who have competence in media development. Of course, this is not easy, so intense communication is needed to produce media products that are truly following the characteristics of the study concept.

The second question presented to the lecturer was: *Where do you think the weaknesses of students lie in mastering modern physics concepts?* Lecturers must know the weaknesses of each student. These weaknesses are identified through the learning process and the results of the evaluation carried out. Evaluation is very useful for mapping students' abilities, so they can plan their next follow-up. In the process of learning modern physics online, RDA provides a note: *related to the derivation of formulas that must be explained face-to-face.* The statement given is general, maybe most students experience this, or vice versa. But the essence of the comment is the online learning process cause students to lack understanding of concepts, especially in the elaboration of formulations [49]. Many unexpected things can happen to online learning, one of the cases that often occurs is an unstable signal. The unstable signal can cause loading too long, sound is not heard, even outside the application. So not only is the scope of interaction limited to online learning but also the accuracy of the information received is often an issue.

Almost the same statement was given by RDB but more completely, the following statement: *Difficulty in understanding concepts that are abstract and still carried away with basic/classical physics concepts, Basic mathematical ability in deriving modern physical equations.* It was again revealed that the abstract concept of modern physics is the reason for the weak mastery of modern physics concepts among students. The transition from classical physics to modern physics must be understood as a distinct entity. So that students are not trapped in the frame of mind of classical physics when discussing the study of modern physics. Likewise, when asked about the importance of practicum, both lecturers stated that it was very important. Because it can help understand abstract concepts [61]. Next, students' basic mathematical skills did not escape the attention of lecturers. However, mathematical skills are needed in the process of deriving formulations to find relationships between variables in modern physics

[62]. Therefore, basic physics and mathematical physics courses are prerequisites for contracting modern physics courses. So that there are no difficulties when studying more complex topics.

4. CONCLUSION

Based on the description above, several problems faced by students in attending modern physics lectures can be identified, namely: difficulty mastering concepts, internet signal interference, less interesting/monotonous learning, and never doing modern physics practicum. Limited tools are the main factor in the inability to carry out practicum. Practicum allows students to master abstract concepts of modern physics.

5. RECOMMENDATIONS

The implementation of practicum in physics is very important to support learning and give emphasis to aspects of the process. This is based on the purpose of learning physics as a process that is to improve students' thinking skills, so that they are not only capable and skilled in psychomotor, but also able to think systematically, objectively, and reflectively. Therefore, alternative media is needed to be able to practice in place of real laboratories, namely in the form of virtual laboratories. Modern physics lectures using virtual laboratories are expected to help students construct more concrete abstract concepts and are expected to develop students' thinking skills.

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