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Descriptions of Student Needs for Digital Physics Teaching Materials on Particle Dynamics: A Preliminary Study

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Abstract: This research describes the initial study to develop e-modules based on student perceptions. This type of research is descriptive which was conducted in seven high schools in Padang based on school level with 667 students as respondents. Data were obtained using a questionnaire of student needs for teaching materials consisting of four indicators, namely student characteristics, implementation of physics learning, use of teaching materials in physics learning, and student needs for teaching materials. The results showed that as many as 67% of students experienced difficulties in physics subjects, supported by 53% of teachers who provided feedback at the end of each physics lesson and 45% of teaching materials used were less varied, in other words 80% of students needed other learning resources containing text, images and learning videos that were studied independently. The results of this study are expected to be the basis for the development of e-modules and efforts to improve the quality of physics learning in high school.

Keywords: E-module; Learning physics; Needs analysis; Physics teaching material

Introduction

During the two-year Covid-19 outbreak in Indonesia, learning was conducted online. The government made a new policy to implement offline learning, marked by the decline in the spread of Covid-19 in Indonesia (Hariyani, 2021). The process of implementing learning in schools is carried out partly online and offline which called blended learning. Blended learning is a combined learning system between offline and online learning (Putri et al., 2021). One of the lessons implemented with blended learning is physics learning (Kusyanti, 2022).

Physics is one of the subjects based on the ability of calculation, reasoning, and suitable logic, as well as a compulsory subject for students who specialize in mathematics and natural sciences. Physics also requires students to understand physics concepts in a directed manner (Mussani et al., 2015). Students should have ability to give reason, communicate, solve problems, and use physics in their daily life (Malina et al., 2021). However, while teaching and learning physics, students often need help with abstract material (Fatimah, Sumberartha, & Setiawan, 2023). Students think physics must be explained by the teacher in details (Istyowati, Kusairi, & Handayanto, 2017). Factors that influence students' difficulties in physics because students have not mastered the material well, physics is considered a complex concepts of all subjects in school (Ma'rifa, Kamaluddin, & Fihrin, 2016).

One of the physics materials that students need help in understanding is particle dynamics (Novitasari, 2016). Difficulties in understanding particle dynamics are caused by differences of students' initial ideas (preconceptions) of learning materials. Some students' perceptions are as they should be, and some are not. Some of the students' difficulties in understanding particle dynamics are in the sub-topic material of Newton's law, the description of the direction of the resultant force, and the application of Newton's law in everyday life (Mariati, 2021). Particle dynamics requires understanding the concept of force and Newton's law. However, to obtain this understanding, students must first learn the concept of motion kinematics (Hafizah,

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Misbah, & Annur, 2018). This is because students must be able to apply Newton's law as the basic principle of dynamics to problems of straight motion, vertical motion, and regular circular motion in everyday life.

Another factor that affects the difficulty level of physics material is the use of teaching materials for students (Gumilar & Effendi, 2022). Teaching materials used during physics lessons are still in printed form (Rachman, 2018). The materials are presented in a language that is difficult to understand, so students need help to develop their knowledge (Kurniawan, Pujaningsih, Alrizal, & Latifah, 2018). Therefore, teachers must be creative in developing and creating teaching materials so that students can be more interested in studying physics and the material presented can be understood by students.

Developing an efficient, systematic, and effective learning process can be done by using other-based teaching materials (Kasih, Sundaryono, & Nursa'adah, 2021). Teaching materials can be electronic-based, such as e-modules. E-modules are electronic learning materials that have advantages compared to printed modules (Muniroh, Pratiwi, Ariswan, & Wilujeng, 2023), namely the presence of audio, video, images, animations, quizzes, can provide automatic feedback, and facilitate independent learning problem-solving by students (Cheva & Zainul, 2019), and can be used with computers, via laptops, tablets, or even smartphones (Nurmayanti, Bakri, & Budi, 2015). The advantage of this e-module is the acquisition of effective models and methods to improve the quality of student learning (Fauza, Hermita, & Afriyani, 2023). E-modules are defined as electronically designed learning devices containing systematic and exciting material to achieve the expected competencies (Puspitasari, Hamdani, & Risdianto, 2020).

The advantages of electronic teaching materials (e-modules) are (1) the content of e-modules containing material and practice questions is presented in various ways, not only in the form of text but also in the form of images and videos that support learning material (Rahmatullah, Bahtiar, & Maimun, 2023), (2) e-modules can facilitate student learning as desired (Puspitasari et al., 2020). However, the use of e-modules could be more optimal when the existing e-modules could optimize students' ability to understand physics concepts (Setiawati et al., 2018). Therefore, it will be even more effective if the learning model is used in conjunction with the e-module that has been created (Kasih et al., 2021).

One learning model that allows students to use modules is the POE (Predict-Observe-Explain) model. The POE model is suitable to use during physics learning (Pakaya & Mursalin, 2019). The POE model is one of the models developed to determine students' ability to predict a natural phenomenon and its reasons (Papilaya & Tuapattinaya, 2022). The POE model allows students to interact directly as they explore a concept or learning process skill (Kasih et al., 2021). This model uses several scientific methods, namely predicting or hypothesizing (Predict), making observations related to their hypotheses (Observe), and analyzing the suitability of hypotheses with observations (Explain) (Liew & Treagust, 1998). Therefore, the POE model can help teachers to improve students' conceptual understanding of existing knowledge and find solutions to overcome the problem of misconceptions in physics learning.

Based on the observation at SMAN 2 Padang, some information on the problems that occur in this study was obtained. Based on observations at SMAN 2 Padang, it obtained some informations, including the use of teaching materials still in printed form, such as text books and worksheets; teachers have applied learning models in physics learning, such as Problem-Based Learning (PBL), Project Based Learning (PjBL), and discovery learning models, but the implementation has not been maximized by the teacher himself in physics learning; low understanding of student concepts in particle dynamics material; and less than optimal provision of feedback from teachers to students during physics learning.

Physics is one of the subjects that is based on the ability of calculation, reasoning and good logic as well as a compulsory subject for students who take a specialization in the field of mathematics and natural sciences. Physics also requires students to understand physics concepts in a directed manner (Berlian, Taufik, & Triyani, 2023). It is expected that students will be able to reason, communicate, solve problems and use physics in everyday life (Malina et al., 2021). During the process of teaching and learning physics activities, students often have difficulty with abstract material in physics subjects. Students think that physics lessons are still difficult to understand (Istyowati et al., 2017). Particle dynamics material is one of the physics materials that is difficult for students to understand based on student learning outcomes and teacher interviews. According to Taqwa's research (2017), students' understanding of particle dynamics material still needs to be improved. This is evidenced based on teacher interviews, the actual conditions in the field of students' daily test scores on particle dynamics material are still low. Based on the interview, the teacher said that students experience conceptual errors in particle dynamics material, including the concept of Newton's Law, and students' errors in determining the direction of forces in everyday life applications such as on inclined planes. Students are

also mistaken in using formulas in conceptual questions on particle dynamics material.

Particle dynamics material is one of the physics materials that students need help understanding based on student learning outcomes and teacher interviews. According to Taqwa's research (2017), students' understanding of particle dynamics still needs to improve. This is evidenced based on teacher interviews; the actual conditions in the field of students' daily test scores on particle dynamics material are still low. Based on the interview, the teacher said that students experienced conceptual errors in particle dynamics material, including the concept of Newton's Law, and students' errors in determining the direction of the force in everyday life applications such as on inclined planes. Students are also mistaken in using formulas in conceptual questions on particle dynamics material.

Before developing a teaching material that suitable for students. We need to conduct student's need analysis. This activity purposed to find out the problems of students in learning at school (Malina et al., 2021) and show how important the teaching materials development carried out in a study (Malina et al., 2021). An accurate needs analysis is expected to fasilitate students' needs for teaching materials in physics learning.

Method

This research was descriptive research. The purpose of descriptive research is to describe the facts and characteristics of the object being studied systematically and accurately (Sukardi, 2004). This research was also conducted to determine the basic problems needed in the development of strategic problem-based learning tools to improve students' relational understanding by analyzing the needs of teachers and students. Through analysis can define a problem to be given a solution. The procedure of this research is illustrated in Figure 1.

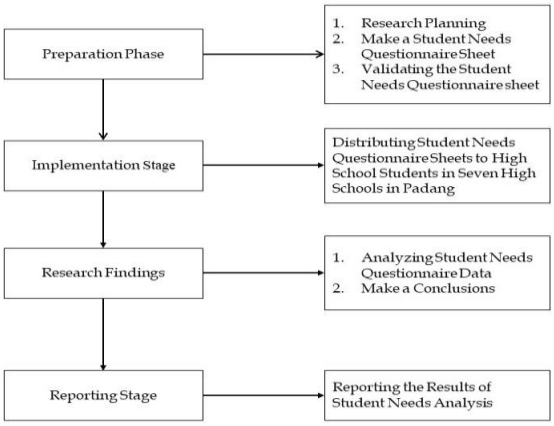

Figure 1. Research procedure

The data was obtained using a questionnaire, which consisted of four indicators: student's characteristics, the implementation of physics learning, the use of teaching materials in physics learning, and student's needs for teaching materials. The questionnaire helps to find information about students' needs for teaching materials in physics learning. The data collection process was carried out in 7 high schools in Padang, West Sumatra Indonesia that were classified according to the school level based on the National Examination scores in 2019 (Kemendikbud Ristek, 2019).

Six hundred sixty-seven students of class X majoring in Mathematics and Natural Sciences were randomly selected as the research sample. The data were analyzed using descriptive statistics. Descriptive statistics describe or provide an overview of the object of study using sample or population data in this way (Sugiyono, 2014).

Result and Discussion

The research results on analyzing student needs for teaching materials are based on descriptive research. The needs analysis stage employs observation and a questionnaire to determine the use of teaching materials in physics learning. Based on observations in the field, the actual conditions were obtained based on the problems in this study. The problems found in physics learning include learning still using teaching materials in printed form, teachers need to learn the POE model, and the common understanding of student concepts in particle dynamics material. To develop an electronic-based module (e-module), it is necessary to analyze student needs. This activity aims to find out the problems experienced by students in learning physics at school. It shows how important the development of teaching materials is carried out in a lesson.

The components of the student questionnaire instrument regarding the needs of teaching materials consist of 4 indicators. The composition of the data from the questionnaire results of student needs can be seen as Table 1.

Based on Table 1, it is shown that 70% of students enjoy learning physics, but 67% of students have difficulty in understanding physics material, and 69% have difficulty solving physics problems. Most students need help with physics material due to several influencing factors. Some of these obstacles are that students have not mastered the material well, and physics is considered a complex material from all subjects in school (Ma'rifa et al., 2016). During physics learning, 71% of students struggle to understand the material. The reason why students take a long time to understand materials is that learning tends to give more

portion for teacher than students (Tahya, Dahoklory, & Dahoklory, 2022). For instance, teachers explain learning materials in class while students only hear explanations from teachers without being active in class (Mujahida & Rus'an, 2019), so students are less able to actualize their abilities (Istyowati et al., 2017).

Table 1. Characteristics of Learners

Indicator	Students' Response
Characteristics of Learners	70% of students enjoy learning physics 67% of students difficult to understand physics concepts and 71% of them take a long time to understand physics concepts 69% os students difficult to solve physics questions 83% of students know about audio, 82% of students know about visual, 85% of students know about video, and 71% of students know about virtual laboratory 65% of students understand the material when audio is presented, 75% of students interest in pictorials and diagrams, 80% of students like learning videos, and 66% of students like virtual laboratory 71% of students keen on e-modules accompanied by videos, 75% of them like animations, and 68%of them like virtual laboratory 76% of students are proficient in using technology (smartphone/ computer)

Nowadays, education is closely related to technological development. Students already know the development of technology (76%) (Adha, Reyza, & Taqwa, 2022), as well as students already know audio (83%), visual (82%), video (85%), and virtual laboratory (71%). Students need other teaching materials to support physics learning and learning resources that can be understood and learned (Maslahah & Rofiah, 2019). Learning will be easier to understand if physics teaching materials are presented with audio (65%), image and diagram media (75%), video (80%), and virtual labs (66%). Students want technology-assisted teaching materials that they can study independently (Herawati & Muhtadi, 2018). Students prefer to learn physics using electronic-based module (e-module) accompanied (Muniroh et al., 2023) by videos (71%), animations (75%), and virtual laboratory (68%). E-modules equipped with videos, animations and virtual laboratories in physics learning can be used as learning media. The learning media can help students as a medium for explaining the material to be learned by students, students will better understand and understand the material studied and be motivated to take lessons. Thus, students need independent teaching materials that are equipped with supporters, such as text, images, virtual labs, and learning videos.

Based on Table 2, around 79% of students believe that physics learning is dominated by teacher-centered. The teacher-centered education system can degrade human dignity because some absolute things are common knowledge, such as the teacher knowing everything and the student knowing nothing, the teacher always talking, and the student listening (Rozali, Irianto, & Yuniarti, 2022). Even though the teacher already allows students to predict (54%), observe (49%), and explain solutions to the results of the problem (49%), the implementation could be more optimal. Another factor that causes a low understanding of student concepts is the lack of teacher feedback to students; based on the questionnaire results, 53% of students have yet to receive feedback from the teacher at the end of each lesson. Feedback is a learning activity provided by the teacher that acts as a stimulus for evaluation and can be used to identify and correct misconceptions experienced by students. Feedback is lacking by teachers at the moment, due to limited learning time with a large number of students (Rahma, Arief Taqwa, & Adi Pramono, 2020) and not being able to give individual feedback to students (Sulistyowati, Sujito, & Kusairi, 2017).

Table 2. The Implementation of Physics Learning

Indicator	Student Response
The Implementation of Physics Learning	79% of physics learning is dominated by teacher 54% of students are allow to do predict activity 49% of students are allow to do observation 49% of students are allow to do explaination 53% of studenst getting feedback from teachers 49% od students get evaluated in the form of conceptual questions and 78% in the form of mathematical questions

The effort that teachers can make to overcome this problem is to apply the recitation method which allows students to learn independently (Sundari, Dewi, Saputra, Jhora, & Rahim, 2016). The applied recitation is modified into a computer-assisted program called the recitation program (Sutopo, Jayanti, & Wartono, 2016). This program contains various assignments in the form of questions on physics concepts and principles and the provision of corrective feedback, which is helpful for remediating student concept errors while learning from home (Sundari & Dewi, 2021). In addition, providing corrective feedback is also intended so that students know their weaknesses and reinforcement during

independent learning (Amalina, Taqwa, & Suyudi, 2021; Sundari & Dewi, 2021). Resitation program in physics learning has an influence on the success of students solving problems (Sutopo et al., 2016). However, another cause of students' common concept understanding can be seen in the assignment given by the teacher (Hidayati & Taqwa, 2022). Around 49% of the tasks given by teachers are conceptual problems, and 78% of teachers give tasks in the form of mathematical problems. Based on the results of the questionnaire, it is proven that the assignment given by the teacher so far is still in the form of mathematical problems, and only a few give conceptual problems (Shidik, 2020). The reason teachers still give assignments in the form of calculation problems is that teachers tend to use problems that have been prepared and given to students before (Anita, Tyowati, & Zuldafrial, 2018). Therefore, it is indispensable that teachers give assignments to students equally between mathematical problems and concept problems. Assignments or working on practice problems given by teachers to students aim to make students familiar when facing similar or unsimilar cases (Gumilar & Effendi, 2022).

Table 3. The Use of Teaching Materials in Physics Learning

Indicator	Student Response
The Use of Teaching Materials in Physics Learning	74% of students using printed-teaching materials 39% of students using teaching materials made by teachers and 45% of students have varied-teaching materials 73% of students have not used digital-based teaching materials 64% of students feel that teaching materials are used insufficiently as learning resources

Based on Table 3, 74% of the teaching materials in school are printed. Printed teaching materials used by students tend to be informative and simple and contain only practice questions (Puspitasari, 2019). The content strategy and distribution in printed teaching materials must be better structured to seem attractive (Oktavia, Ramalis, Karim, & Feranie, 2020). The material presented in the printed teaching materials is abstract and complicated, so students are avoid to read it (Suryawirawati, Ramdhan, & Juhanda, 2018). Therefore, students need help in developing their knowledge even they have the printed-teaching materials on their side (Kurniawan et al., 2018). Based on observation, only 39% of teachers make their own teaching materials, and the use of varied-teaching materials has remained the same (approximation of 45%). Consequently, students need other teaching materials to support physics learning activities and learning resources that can be understood and studied independently. This is because 64% of students stated that learning resources still needed to be added. Moreover, about 73% of students want technology-assisted teaching materials like e-modules. E-module requires students to solve problems using their way without minimal guidance from the teacher (Maslahah & Rofiah, 2019).

Table 4. Students' Needs for Teaching Materials

Indicator	Student Response
Students' needs for teaching materials	75% of students understanding the material quickly if the teaching materials are made by the teacher 49% of students using digital-based teaching materials 77% of students Requires teaching materials that can lead to prediction, observation, and explanation 80% of students requires teaching materials for independent study, 76% of student ted to have teaching materials that can be accessed by smartphone/computer and 82% od students are enjoying an e-modules 82% of students requires feedback in e-module

Table 4 showed that 75% of teaching materials used during physics learning are made by teachers that easier to understand. Around 49% of students have used e-modules during physics learning, and 77% of students still need e-modules that can lead them to predict, observe, and explain problems related to physics. They wanted electronic-based teaching materials that allow them to learn independently (80% of students). About 82% of students also stated that they agree if there are digital teaching materials related to physics material provided in physics learning. However, 82% of students stated that teachers scarce provide feedback in the learning evaluation. The current lack of feedback by teachers is due to limited learning time, so teachers cannot give feedback to students individually with many students (Sulistyowati et al., 2017).

The solution to these problems is the use of electronic-based teaching materials (e-modules) and learning models that are contextually appropriate to improve students' concept understanding (Nurmayanti et al., 2015). Understanding conceptual includes information categories of knowledge and classification and more complex relationships in structured information, thus requiring a higher conceptual understanding in physics learning (Apriani, Hakim, & Sulistiawati, 2021). Thus, understanding the concept is an important goal in physics learning. To achieve that, the most important thing is to understand the concept itself. The Predict-Observe-Explain (POE) model is

suitable to integrate with teaching materials such as e-modules (N. Putri, Junaidi, Hakim, & Anwar, 2022) because POE can provide predictions, observations, and conclusions in (Suryawirawati et al., 2018). Students are encouraged to understand the physics concept with the opportunity they receive and anticipate problems that arise during learning (Wardana & Ardani, 2021). The advantages of the POE model can be used to explore students' thoughts and initial knowledge based on the results of students' predictions and find out the students' perspectives so that teachers can find out students' thoughts and increase good interactions between students and teachers, and can provide encouragement for students to explore concepts that they do not understand, provide opportunities to prove the predictions and increase students' curiosity (Rahmawati, Sarwanto, & Budiawanti, 2021).

Based on the needs analysis, physics learning problems in 7 high schools in Padang City showed the importance of developing teaching materials in the form of e-modules. This e-module is integrated with POE, which is related to POE syntax including students' predictions about the results of demonstrations (Predict), conducting experiments (Observe), discussing the reasons for the predictions they make, and finally, explaining the results of predictions from their observations (Explain) (N. Putri et al., 2022). Through the development of POE-based e-modules, students are expected to be more independent, understanding the physics concepts, and be more active in learning.Students are also more challenged to prove their predictions through experimentation or observation activities (Pakaya & Mursalin, 2019). According to the needs analysis, a teaching material is needed for students to learn independently in the form of an e-module that integrated with POE model and providing feedback on physics material, particularly in Particle Dynamic.

Conclusion

From the data analysis that has been done, several things can be stated from this study. First, the characteristics of students are that they enjoy learning physics, but find it difficult to understand the lesson, and need help in solving physics problems. Second, in the implementation of physics learning, it was found that the teacher's role is still dominant in physics learning. Third, the use of teaching materials in physics learning shows that they still use printed teaching materials. Fourth, physics learning needs to provide optimal feedback. So, the conclusion of this analysis is that it is necessary to develop teaching materials in physics learning in the form of e-modules integrated with the POE model equipped with computer-assisted feedback. This e-module is expected to be used by students to learn physics independently, anywhere and anytime.

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Author Contributions

All author have significant contibution in this manuscipt. H.H validated the research instrument, P.D.S developed an instrument, D.S has designed the e-module, and N.I.A has contribution to conduct preliminary research. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

There is no conflict of interest.

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