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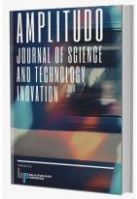

Efforts to Create an Interesting and Meaningful Physics Learning Environment with a Project-Based Learning Model

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Abstract: The rapid development of the times will certainly bring up new skills, especially in the era of the Industrial Revolution 4.0 and Society 5.0, which are currently developing. Digital technology is the most important part in building this era. So that this era makes internet-based technology a human companion to carry out their daily activities. With the new environment, of course, the world of education as one part that plays a role in producing human resources must be wise in creating meaningful learning conditions. The condition of a meaningful learning environment is needed in almost all subjects, including physics. One of the learning models that can change or modify the student learning environment is to apply a project-based learning model (PjBL) with six stages, namely: 1) Start with the Essential Question; 2) Design a Plan for the Project; 3) Create a Schedule; 4) Monitor the Student and the Progress of Project; 5) Assess the Outcome; and 6) Evaluate the Experience. The application of the project-based PjBL model received a positive response from students at MA Plus Nurul Islam Sekarbela, this was reinforced by the percentage of student interest in project-based physics learning, which was 55.55% in the "very interesting" category and 26.98% in the "interesting" category, so that by using the model PjBL makes students feel very interested in learning by producing a product, namely student worksheets and learning videos "Physics Experiments" which can be used as guides for other students in need.

Keywords: Learning Environment; Interesting and Meaningful Physics; Project-Based Learning Model

Introduction

The development of the times, which continue to change every time, will certainly require the emergence of new skills that must be mastered. When referring to the current conditions where humans have entered the era of the Industrial Revolution 4.0 and Society 5.0. Digital technology has become a driving part of the Industrial Revolution 4.0, where artificial intelligence is associated with the Internet of Things (IoT), while Society 5.0 is a human-centered and technology-based concept of society (Suherman, et al., 2020). So that this era makes internet-based technology a human companion to carry out their daily activities.

With the new environment, of course, the world of education as one part that plays a role in producing human resources must be wise in creating meaningful learning conditions for students. Meaningful learning is a learning condition in which students not only understand the material being studied but can also apply it to real situations in their daily lives. According to Rahman (2013), it is stated that "meaningful learning" is a process of connecting new information to relevant concepts. contained in a person's cognitive structure. The cognitive structure in question includes facts, concepts, and generalizations that have been learned by students.

The condition of a meaningful learning environment is needed in almost all subjects, including physics. Material in physics that tends to be associated with numbers by students is certainly a challenge for the subject's teachers. This condition needs to be addressed immediately to avoid the occurrence of a mindset that is not entirely correct about physics subjects. If referring to

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the process, of course, physics subjects cannot be separated from other subjects such as chemistry and biology, especially mathematics. However, to change this perspective, teachers need to create a learning environment that is different from the previous conditions.

One of the learning models that can change or modify the student learning environment is to apply a project-based learning model (PjBL). Based on these problems, the researcher is interested in conducting research to create an attractive physics learning environment for students with a project-based learning model.

Method

This The research is a descriptive research with a combination of quantitative and qualitative methods. The quantitative method uses closed-answer questionnaires, while the qualitative method describes the results of research data either from questionnaires or from observations and learning activities in the classroom. The research data was in the form of a closed questionnaire with "yes" and "no" answers describing student responses regarding the creation of an interesting and meaningful learning environment using a project-based learning model. The questionnaire data was then analyzed using the following equation to obtain the percentage value of each statement in the questionnaire. (Fauzan, et al., 2022).

$$\frac{Students\ who\ answered\ yes/no}{Number\ of\ students\ who\ answered} \quad (1)$$

The category of analysis data used and adapted refers to Purwanto (2019), as shown in the following table.

Table 1. Categories of Student Responses about Creating an Interesting and Meaningful Learning Environment

Persentase	Category
86 – 100%	Very good
76 – 85%	Good
60 – 75%	Pretty good
55 – 59%	Not good

Result and Discussion

Physics Learning

Physics is one of the branches of natural sciences that studies various natural phenomena that are not living or material in the environment, space, and time, as well as the processes of interaction in them (Mujizatullah, 2018). According to Harefa (2019), physics is a form of knowledge that describes the collective efforts, findings, insights, and wisdom of mankind.

In essence, the science of physics consists of three main components, namely physics as a product (a body of knowledge), a process (a way of investigating), and an attitude (a way of thinking) (Ainiyah, 2018; Fatimah, et al., 2021).

1. Physics as a product (a body of knowledge)

Physics is a collection of knowledge that examines and studies various events that occur in nature and can be caught by the five human senses.

2. Physics as a Process (a way of investigating)

Physics provides an overview and information related to the methods used in discovering and collecting knowledge. Regarding the process of gathering information, physics uses a systematic scientific method so that the various results and knowledge obtained can be accounted for.

3. Physics as an Attitude (a way of thinking)

Physics in finding and producing products requires thinking, creativity, and scientific attitudes such as curiosity, criticality, objectivity, diligence, openness, and responsibility.

Based on the above components, of course, learning physics is not only oriented toward cognitive outcomes but also focuses on the learning process. In addition, learning physics, emphasizes being able to produce products that are beneficial for both students and others. So that the application of project-based learning models is one way to create an interesting and meaningful physics learning environment for students.

Project Based Learning (PjBL)

Project-based learning is a learning model that uses projects or activities as learning media (Setyowati & Mawardi, 2018). According to the Ministry of National Education (2003), project-based learning is a learning approach that requires comprehensive learning conditions where the student learning environment is designed so that students can conduct investigations of authentic problems. Meanwhile, according to Barlenti, et al. (2017), project-based learning is a learning condition that can construct students' knowledge and skills through laboratory or experimental activities so as to increase students' creativity and motivation to learn.

Project-based learning focuses students on a number of motivating problems, and encourages students to deal with concepts and principles of knowledge directly as a first experience. Students are required to think critically until they can finally solve a problem in real life. One of the interesting things about the project-based learning model is that it involves students in designing future learning environments

(Nurhayati, et al., 2020). According to Nurohman (2007), there are The six stages/syntax in the project-based learning model are: start with the essential question, design a plan for the project, create a schedule, monitor the student and the progress of the project, assess the outcome, and evaluate the experience. In detail, the stages in the project-based learning process can be seen in the following Table 1.

Table 1. Project-Based Learning Model Syntax

Stages/Syntax	Activity Description
Start with the Essential Question	The first step in the learning process is to determine the essential questions that can increase students' interest and motivation to learn. The topics used should be contextual, relevant, and often experienced by students in everyday life
Design a Plan for the Project	One of the interesting things in the project-based learning model is the involvement of students in designing future learning activities. So, with this, it is hoped that the condition of belonging to students will arise in the project or activity being carried out
Create a Schedule	Teachers and students jointly determine or arrange a schedule for implementing the stages of learning activities. This schedule is very necessary so that learning activities are more focused and do not waste a lot of time
Monitor the Student and the Progress of Project	One of the teacher's tasks in the current learning process is that of a facilitator, so at this stage the teacher needs to monitor the progress of the results of activities carried out by students at each meeting schedule
Assess the Outcome	The assessment process needs to be carried out to determine or measure the achievement of learning materials so that they are able to provide feedback to students
Evaluate the Experience	In the final stage, all parties, both teachers and students, need to reflect on the activities and project results that have been carried out. At this stage, students need to express their feelings and experiences during project-based learning activities

Creating an Interesting and Meaningful Physics Learning Environment for Students

An interesting and fun learning environment will certainly be able to increase students' interest in learning physics. Relaxed learning occasionally needs to be created by the teacher to relieve the tension that exists in students. The existence of pressure such as fear will certainly have an impact on students' concentration and desire to learn (Mindiharto, 2013; Trinova, 2012). Therefore, one way for teachers to create an interactive and interesting learning environment for students is to apply a cooperative learning model. This is in line with the statement put forward by Yogihati (2010) that meaningful learning is an approach to learning through active learning methods toward independent learning.

The ability to learn independently becomes the ultimate goal of meaningful learning. To achieve this goal, the physics learning process needs to be designed so that students are able to decide what to learn and how to learn it (Yamin, 2007). One of the models used to create interesting and meaningful physics learning situations for students is project-based. Teachers begin to introduce and apply project-based learning models to physics subjects due to a phenomenon where most students look more active when it comes to collaborating with friends or peers (Rizaldi, et al., 2021b). Therefore, to maximize this potential, teachers need to facilitate students' desires to create the desired learning conditions and are expected to increase student involvement.

In addition to creating an interesting and meaningful learning environment for students, teachers have also begun to introduce digital literacy in supporting project activities. It is undeniable that, at present, almost all students at the high school level already have gadgets such as smartphones to support daily activities (Rizaldi & Fatimah, 2022). One of the uses of smartphones in project-based learning is as the main learning resource and at the same time as a place to disseminate the work or projects of each group. Learning in the 21st century currently does not make school textbooks the main learning resource. The role of technology in providing various information needs to be introduced to students so that the material being studied is more diverse (Wijaya, et al., 2016). Of course, with this condition, students can expand and deepen the material learned at school.

The implementation of interesting and meaningful physics learning activities in accordance with the stages of the project-based learning model at MA Plus Nurul Islam Sekarbela can be described as follows

1. *Start with the Essential Question*

This project-based learning begins with the teacher introducing the systematics and learning materials that will be carried out for several meetings in the future. The teacher needs to explain the purpose of using the model and the conditions to be achieved by students. So that both teachers and students have agreed and understood their respective tasks in the future while carrying out the learning process. Researchers in this case took some

physics materials that are used as material to be taught with project-based learning models, including those related to particle dynamics (Newton's Law) in class 10 and static fluids in class 11. The choice of these two materials is due to the potential for various kinds of sub-materials that can be taken by students to be used as class projects.

2. *Design a Plan for the Project*

Project-based Physics learning activities are carried out by dividing students in the class into several heterogeneous groups. The teacher needs to consider the division of groups so that the distribution of students is more evenly distributed so as to minimize the gathering of active and skilled students in the same group. This activity was designed and implemented in five meetings that were systematically planned with students. The project developed in this physics learning process produces two outcomes, including student worksheets and learning videos (practice activities).

The output of the project at the end of the lesson will be disseminated through each student's social media. This aims to start familiarizing students with using social media (Facebook, Instagram, WhatsApp Status, and Youtube) for learning purposes. A project system like this, of course, in addition to providing direct experience to students, also allows other people who see this assignment already on social media to get new inspiration to be able to apply it to learning at school.

3. *Create a Schedule*

The learning schedule developed using a project-based model consists of five meetings with the following details.

a. The First Meeting

The teacher and students jointly determine the topic of the project study that refers to the subject matter that has been determined. Determining the topic is very important because this is the reference that will be used by students in developing future projects. After the topic is determined, at this meeting, students and their group partners carry out literacy activities to create a theoretical framework or theoretical study related to the topic.

Before carrying out any further activities, each group must first understand the concepts related to their respective projects. This condition is to reduce the possibility of errors that can occur in the next meeting. In addition, at the first meeting, the teacher and students design a time or schedule for project-based learning activities.

b. Second Meeting

After the topic and theoretical study have been completed at the previous meeting, the students need to determine the type of practicum that will be carried out in the future. At this stage, students and their group mates are asked to identify various tools and materials and develop their own experimental steps. By providing opportunities for each group to determine the type of experiment to be carried out, the teacher is also required to have more knowledge, and indirectly, the teacher also needs to learn to be able to monitor the development and progress prospects of each group because of the different types of experiments developed.

c. Third Meeting

Before entering the third meeting, the teacher asked students to prepare a table of experimental data that would be used during the learning process later. The third meeting focused more on conducting experimental activities based on the designs that had been carried out at previous meetings. So students try out and assess their own designs that have been made and prove the truth of the material concepts contained in the theoretical study section. By encouraging students to carry out various activities, it is hoped that various skills that are expected to exist in students in the 21st century will emerge.

These skills include the ability to cooperate between group friends, communicate while discussing designs that have been developed, think critically, and be skilled in solving various problems that arise in groups. This is in line with the statement of Nurhayati, et al. (2020b) that 21st century skills will emerge if students work together in a group rather than working independently.

d. Fourth Meeting

At this meeting, students and their groupmates begin to compile and design the final product of the project-based learning process that has been carried out. This activity trains students to be able to account for the results of experiments that have previously been carried out. In addition, the teacher also needs to instill scientific values at this meeting, including honesty, responsibility, discipline, being systematic and open, etc., so that students do not try to change the experimental data that has been obtained. Whatever the results obtained, they need to be conveyed openly through the presentation process at the end of the meeting. Presentation materials or output products from this learning activity are in the form of student worksheets and learning documentation videos.

e. Five Metting

The last meeting in the learning process is to present the results or products of each group in front of the class, witnessed by all students from other groups.

This activity needs to be carried out to jointly evaluate the results of the activities that have been carried out during the last four meetings. Sometimes the designs that have been developed are not always in accordance with the existing theory. Therefore, the teacher needs to explain to students that many factors cause differences and that this is normal in an experimental activity. The difference between data and theory does not mean that what students do is a failure. This is what will be able to make students more critical and more motivated to learn physics.

Table 2. Schematic for Implementation of Project-Based Physics Learning

Type of activity	Meeting				
	1	2	3	4	5
Determining the learning topic	√				
Develop a framework of learning topics	√				
Develop a schedule for learning stages	√				
Determine the type of physics experiment to be carried out		√			
Determine the tools and materials as well as the experimental steps to be carried out		√			
Compile a table of experimental data		√			
Testing the experimental design that has been developed			√		
Designing final products such as student worksheets and learning videos				√	
Showing the final product through the presentation process in front of the class					√

4. *Monitor the Student and the Progress of Project*

Monitoring is intended to check and see how far each group's projects have progressed. This stage really needs to be considered by the teacher because the nature of the project-based learning model, which is not all done during the learning process, certainly presents its own challenges for students. Several groups had relatively slower progress prospects than other groups during the application of this model.In this condition, the teacher needs to be sure about the obstacles experienced by students so that the prospect of project progress can be said to be late. Without assistance from the teacher, it will certainly be difficult for students to get excited and motivated to continue their project. So, it is hoped that all groups can complete their respective projects on time and according to the schedule that was mutually agreed upon at the first meeting.

5. *Assess the Outcome*

At the end of the activity process, the mandatory activity that must be carried out by the teacher is to conduct an assessment related to student performance in the learning process. Likewise, when using this project-based learning model. At this stage, each group will present the results of the project in the form of student worksheets and video documentation in front of the other groups. With a process like this, of course, each group can provide new information or material for other groups. This is because each group has different sub-materials, so indirectly, the group presenting will become a source of learning for other groups. In this stage, the teacher plays a role in ensuring that the concepts and materials presented are in accordance with the truth so that there are no misconceptions among students.

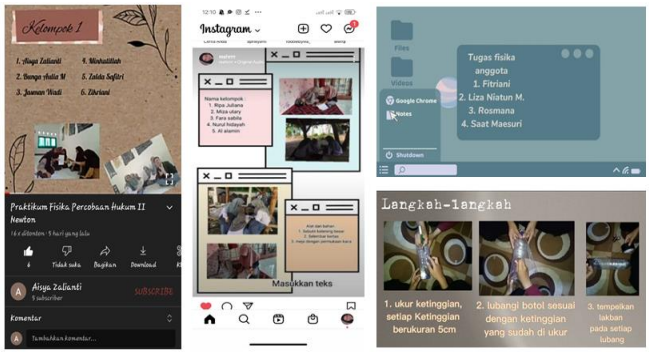

Figure 1. Products in the form of Learning Videos about Physics Experiments

6. *Evaluate the Experience*

The last stage of the project learning model applied in physics learning is joint evaluation. The evaluation activities carried out not only focused on the products produced but also on the experiences that had been felt by students during the project-based learning process. The use of this model certainly changes the climate or atmosphere of learning physics for students, and this change will certainly be addressed by students. This attitude can be positive or negative. However, in general, students tend to be very happy if the physics learning process is carried out in a relaxed manner and involves students.

Student Responses Related to an Interesting and Meaningful Physics Learning Environment with a Project-Based Learning Model

An attractive learning environment is one way for teachers to increase student interest and motivation, especially in physics. Student responses related to experiences and feelings experienced when learning physics by applying project-based learning can be seen in the following table.

Table 3. Student Responses Related to the Physics Learning Environment with a Project-Based Learning Model

Statement	Answer		Category
	Yes	No	
I feel learning physics with the PjBL model gives it a different atmosphere	100%	0%	Very good
I feel that the physics material learned with the PjBL model is related to everyday life	85%	15%	Good
I feel happy when the classroom or learning environment used is not the same every time	90%	10%	Very good
I think learning physics with the PjBL model is more interesting	87%	13%	Very good
I am more challenged to learn physics if given certain problems related to the learning material	79%	21%	Good
I feel that studying in groups makes learning less boring	98%	2%	Very good
I feel more open with friends when learning to use the PjBL model	76%	24%	Good
I feel that the skills I have are getting better as I learn with the PjBL model	77%	23%	Good
I find it easier to understand the context of the material being studied with the PjBL model	68%	32%	Pretty good
I am happy when the work I do can be seen by many people through social media	88%	12%	Very good

The project-based learning model provides a new atmosphere for the physics learning process in the classroom. This can be seen from the student responses, with 87% stating that the learning environment with a project-based model is more interesting. Learning using the PBjL model is included in student-centered learning (Chasanah & Nuroso, 2016; Sularmi, et al., 2018). This fosters students' self-confidence in being creative and innovative, which is of course under the supervision or monitoring of the teacher. In accordance with the development of the world of education, students are required to develop their potential in order to broaden useful insights for their future (Rizaldi, et al., 2021c). This is because one of the characteristics of the PjBL model is that it is closely related to everyday problems.

To find out the general response related to student interest in participating in project-based learning, see the following figure:

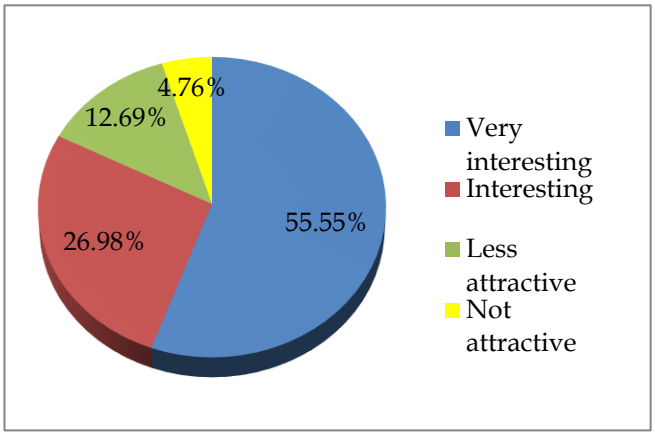

Figure 2. Percentage of Student Interest in Project-Based Physics Learning

Seen in the diagram above, the percentage of student interest in the PjBL model is 55.55 in the very attractive category and 26.98% in the attractive category. This indicates that the PjBL model can bring a new atmosphere to the learning process. Learning is not only monotonous with the lecture method delivered by the teacher but can give students confidence to try things they have not done or are afraid to do (Jauhariyyah, et al., 2017; Noviyana, 2017). Fear in the sense that students feel they will be blamed by the teacher if things are done without supervision. This is in line with the opinion of Sari & Angreni (2018), which states that the PjBL model can help students increase creativity.

Conclusion

Based on the discussion described above, it can be concluded that the PjBL model uses six stages, namely: 1) Start with the Essential Question; 2) Design a Plan for the Project; 3) Create a Schedule; 4) Monitor the Student and the Progress of the Project; 5) Assess the Outcome; and 6) Evaluate the Experience, to help students in the learning process. This is because PjBL is a learning model that uses projects or activities as learning media, which is in accordance with the current curriculum. Students are thus led to be able to innovate as creatively as possible in the learning process, whether in the classroom or outside the classroom. The results obtained in this study show that students of MA Plus Nurul Islam Sekarbela can make learning products in the form of student worksheets and learning videos about physics experiments. The learning video is the initial provision for students at MA Plus Nurul Islam in trying to develop other products that can increase student creativity and foster good self-confidence in the learning process.

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