Development of online learning devices based on PDEODE 
(predict - discuss I - explain I - observe – discuss II - explain II) 
on the material doppler effect in the covid-19 pandemic era

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Abstract. The impact of the Covid-19 Pandemic changed the world of education, especially in the implementation of Teaching and Learning Activities. In the learning process, for example the teacher no longer has to face to face with students because it can be done online. This research aims to develop an online learning device based on PDEODE (Predict - Discuss I - Explain I - Observe - Discuss II - Explain II). The type of research used is Research and Development (R&D) using the 4-D model (Define, Design, Development, Desiminate). However, this research only reached the develop stage. This online learning device was validated by 6 expert validators, which included 2 material expert validators, 2 media expert validators and 2 learning expert validators. This PDEODE-based online learning devices has already been tested on its product design for teachers and grade X students at SMKN 53 Jakarta. The result shows that the PDEODE based online learning devices is "very good" because it has been through the validation test stage and trial phase with a percentage of achievement as much as 63.77% according to material experts, 89.94% according to media experts and 85% according to learning experts. The results of trials by teachers and participants students show the percentage of teacher responses as much as 94% and overall can be a percentage of 83.18%. Based on the analysis of data that has been collected can be concluded that PDEODE-based online learning devices on the Doppler Effect material are very good/feasible to be developed and used in this Covid-19 Pandemic Era.

1. Introduction
In March 2020, Indonesia was rocked by the emergence of a mysterious virus known as COVID-19 (Corona Virus Disease 2019). Hundreds or even thousands of people have been exposed to the virus and not a few who died. The education sector was also affected by the emergence of this virus. As many countries have done, to prevent the transmission of the corona virus in schools, the Indonesian Minister of Education and Culture issued a circular dated March 24, 2020 which regulates the implementation of education in the emergency period of the spread of the corona virus. This "Learning from Home" policy is appropriate to prevent the spread of COVID-19 in the school environment [1].

Despite having to impose PJJ (Distance Learning) in order to cut off the spread of the corona virus, Retno Listyarti, one of the KPAI commissioners (Indonesian Child Protection Commission) acknowledged PJJ was not effectively carried out on Indonesian children. This is based on the number of complaints received by KPAI related to the burden of assignments given to children, but the learning time is less effective. Based on the results of KPAI's research, the majority of complainants...
are middle school age children. KPAI concluded that PJJ made students experience fatigue, lack of rest and stress. Retno said that during PJJ students complained the teacher only gave assignments but there was almost no question and answer interaction or the teacher explained the material [2].

In Indonesia online / distance learning is regulated through the Ministry of Education and Culture Circular Letter No. 4 of 2020 regarding the Implementation of Education in the Corona Virus Disease Emergency Period (Covid-19). There are three policy points related to online learning, First, online / distance learning to provide a meaningful learning experience, without being burdened with the demands of completing all curriculum achievements for grade promotion or graduation. Second, it can be focused on life skills education, including the Covid-19 pandemic. Third, learning activities and tasks can vary between students, according to their interests and conditions, including considering the gap of access / learning facilities at home.

Thus the teacher's creativity in designing online learning for students also plays an important role. To ensure learning becomes fun, full of meaning, awakens creativity, critical power, and is able to make independent learners certainly not an easy matter. Moreover, teachers cannot face-to-face with students. Foresight of teachers in making designs and methods that are able to lure students to continue to be enthusiastic about learning become noteworthy things.

Based on the results of a preliminary study conducted by distributing questionnaires in the form of needs analysis, it has been carried out at SMK Negeri 53 Jakarta to find out the availability of online learning in Physics only in the amount of 44.95%. This means that physics teachers at the school still have not prepared many online learning tools. And the achievement of students towards the concept of the Doppler Effect is 42.28%. And a percentage of 91.14%, it was found that students need online learning tools to support PJJ during the current emergency.

![The Results of the Student Needs Analysis](image)

**Figure 1** Pie Chart from the Result of the Student Needs Analysis

With the implementation of the 2013 curriculum there are demands for scientific independent learning in the classroom that must be supported by scientific independent learning media and also the learning models used. Examples of learning media that are widely used are Handouts and LKPD. Learning activities in the 2013 curriculum must also utilize the role of information and communication technology to improve the efficiency and effectiveness of learning.

In previous studies [3] obtained the results of the development of lesson plans, modules, worksheets and portfolio assessments categorized as very valid, very practical and effective. But in reality in the field of Physics material that is tested is only limited to knowledge without further investigation for it needs a special model so that students can receive and follow learning well. The model used must also be precise, the goal being that students who take part in online learning can
understand material concepts, another finding in the initial observation is not using virtual media as a teaching aid to explain abstract concepts so that learning does not arrive at the desired goal [4]. The selection of learning models is very important and adjusted to the characteristics of the subject matter [5]. The PDEODE model is a learning model which involves the students' independent activities. This learning model is an important model because it has an atmosphere that can support discussion and diversity in Costu's perspective [6]. Therefore, this model intends to be used to help students make sense of their daily life experiences.

Of course, so that the demands of scientific self-study in situations and situations of emergencies are now being reached, it requires innovation or development in making online learning tools. For this reason, the purpose of this development research is to develop a PDEODE-based online learning device in one of the physics materials, the Doppler Effect for Grade X SMK level.

2. Literature Review

2.1. Online Learning Devices

Learning devices are things that must be prepared by the teacher before carrying out learning. In KBBI, devices are tools or equipment, while learning is a process or way of making people learn. Learning devices are tools or equipment to carry out processes that enable educators and students to carry out learning activities [7]. Learning devices are learning support tools that contain learning plans that describe in detail about the competencies to be achieved by students, learning designs that follow the syntax of certain learning models, guidelines for activities for students and tools to measure the achievement of student competencies [8].

In Permendikbud No. 65 of 2013 concerning Basic and Secondary Education Process Standards states that the preparation of learning tools is part of learning planning [10]. Learning Planning is designed in the form of RPP, Handout and LKPD which refers to content standards. In addition, in the planning of learning also carried out the preparation of media and learning resources, assessment tools and learning scenarios. This research aims to develop learning tools in online form so that all students can experience learning at home properly.

2.1.1. PDEODE Learning Model. The PDEODE learning model was first proposed by Savander-Ranne & Kolari [6]. The PDEODE learning model is a learning model that links students' daily life experiences with the material being taught. This learning model refers to the view of constructivism which is new knowledge built on existing knowledge by constructing knowledge from natural phenomena that are around us [6]. The PDEODE Learning Model (Predict-Discuss-Explain-Observable-Discuss-Explain) has 6 stages:

1) Prediction Stage
2) Stage Discussion I (Discuss I)
3) Stage Explain I (Explain I)
4) Observation Stage
5) Discussion Phase II (Discuss II)
6) Explaining Phase II (Explain II)

In the journal Student and Teacher Perceptions of the Use of Multimedia Supported Predict-Observable-Explain Task to Probe Understanding, said that, learning in the view of constructivism is a learning that requires students to build a concept based on experience that new obtained and connect it with preexisting experience [11]. PDEODE Learning can help students to learn better and build their abilities and beliefs to evaluate the knowledge they have [12].

All stages of PDEODE are written into learning activities in the Free Learning RPP so that the online learning process is more structured and directed.
2.2. Doppler effect.
The Doppler effect is the change in frequency or wavelength of a wave in a receiver that is moving relative to the source of the wave. The Doppler effect is named after an Austrian scientist, Christian Doppler, who first explained the phenomenon in 1842. The Doppler effect can be found on all types of waves, such as water waves, sound waves, light waves, and others.

The concept of the Doppler Effect in physics learning is abstract. Doppler effect learning requires media that can explain the concept of the Doppler effect. Suggestions from media experts and learning design experts about Doppler Effect mobile learning that Doppler Effect mobile learning is made interactive with appropriate animations and simulations so that abstract Doppler Effect material can be presented in a concrete, challenging and enjoyable way [13].

3. Methods
This type of research includes development research undertaken with the aim of developing online learning devices including: Lesson Plan (RPP) for independent learning, Doppler Effect Handout, Doppler Effect student worksheet and Video / animation in the PDEODE-based Edmodo platform for Class X SMK. Development of Online Learning Devices used refers to the 4-D (Four D models) model consisting of define, design, develop and assess [14]. However, this research only reached the develop stage.

3.1. Stages of Research Methodology
This research and development consists of 4 stages:

3.1.1. Define. At this stage, (Thiagarajan, 1974) divides it into 5 activities namely:
   a) Front-end analysis, in this activity needs analysis is carried out to obtain preliminary information from the situation in the field / in class. This needs analysis is done by distributing questionnaires to determine the needs of teachers and students. Needs analysis questionnaire was made with the help of Google form.
   b) Learner analysis, in this activity the characteristics of students are studied, for example abilities, learning motivation and experience background. For example: if the level of knowledge of students is still low, then the writing of learning tools must use simple language and words that are easy to understand. If students' interest in reading is still low, then writing learning tools needs to be added with interesting picture illustrations so that students are motivated to read them.
   c) Task analysis, in this activity analyzes the main tasks that must be mastered by students in order to achieve minimal competence.
   d) Concept analysis. In this activity, an analysis and identification of concepts to be taught is carried out, composing steps to be carried out rationally and adapted to online learning.
   e) Specifying instructional objectives this activity is expected to be able to write research objectives from the results of needs analysis and also write learning objectives along with expected behavioral changes after online learning Learning objectives are written using operational verbs.

3.1.2. Design. (Thiagarajan, 1974) divides the design stage into four activities, namely:
   a) Constructing criterion-referenced test (compiling test criteria), compiling a grid and indicators of questions about the analysis of student and teacher needs. And identify the components of the free learning lesson plan to be made.
   b) Media Selection, choosing learning media that is suitable with the material and characteristics of students. The media that was designed in this study was in the form of Handouts and student worksheet which were adjusted to the Lesson Plan for independent learning that had been made at the beginning.
   c) Format Selection, choosing the form of presentation of learning tailored to the learning
media used. In this case, edmodo was chosen as an academic platform similar to Facebook. Edmodo can be used by teachers, students and parents of students as an educational application based on social networking so it doesn't seem boring. With Edmodo, it will be easier to control interactions between students, and their privacy. No one can enter a class if the group or class code is unknown to the student, and students cannot use it with strangers. It will be easier to know of a violator who is registered at class that uses edmodo.

d) **Initial Design**, this stage is filled with activities preparing a conceptual framework of models and learning tools (material, media, learning) and simulating the use of these learning models and devices in a small scope. The stages of design in this study were carried out to make learning tools in accordance with the framework of the content of the results of the defining stages that had been done previously.

3.1.3. **Development.** At this stage, it is divided into two activities, namely:

a) **Expert Appraisal**, is a technique for testing validation or assessing product viability. In this activity a validation test was conducted by experts in their fields which consisted of 2 material expert validators, 2 media expert validators, and 2 learning expert validators. Furthermore, revisions would be made to improve the learning tools from various existing indicators. This validation and trial aims to control the contents of online learning tools to keep them in line with the needs of the students.

b) **Developmental Testing** is a product design trial / field trial activity on the actual target subject. The product design trial is conducted by the teacher in online learning activities with the help of zoom. Product design trials / field trials are documented.

3.2. **Data analysis technique**

Data analysis techniques from the validation test questionnaire were assessed using a Likert scale assessment with points 1 to 5 as follows:

| No | Alternative Answers     | Score | Weight |
|----|-------------------------|-------|--------|
| 1  | Very good               | 5     |        |
| 2  | Well                    | 4     |        |
| 3  | Enough                  | 3     |        |
| 4  | Less                    | 2     |        |
| 5  | Not good/Very Less      | 1     |        |

Data collection techniques used are quantitative descriptive data analysis, used to process data from the results of the validation of material experts, media and learning as well as teacher validation in the form of input suggestions and improvement criticism contained in the validation instrument questionnaire and qualitative descriptive statistical analysis used to analyze the data obtained in the form of percentage analysis.

The data collected on the validation sheet and the trial questionnaire are basically qualitative data, because each statement point is divided into categories that are Very less, less, Enough, good and very good. The data is first converted into quantitative data according to the weight score. Changes are made using the following formula:

\[
P = \frac{\sum (\text{seluruh skor jwb angket})}{n \times \text{tinggi \text{m}arl responden}} \times 100%\]  

(1)

Where:

- \(P\) = declare percentage rating
- \(n\) = states the total number of questionnaire items
Data on the results of the assessment of the learning tools developed were analyzed descriptively, determining the eligibility criteria and product revisions in Table 2 below:

**Table 2 Likert Scale (Sugiyono, 2013) [15]**

| Level of Achievement | Interpretation |
|----------------------|----------------|
| 81% - 100%           | Very good      |
| 61% - 80%            | Good           |
| 41% - 60%            | Enough         |
| 21% - 40%            | Less           |
| 0% - 20%             | Very less      |

4. Results and Discussion

The product of this development research is a PDEODE-based online learning devices on the Doppler Effect material. Online learning devices made include:

a. Lesson Plans for Independent Learning include: components of learning objectives, steps of learning activities, and assessment.

b. The Doppler Effect handout includes: learning objectives, material summary, HOTS sample problems.

c. LKPD (Student Worksheet) The Doppler effect includes: observation activity instruction sheets, and observation sheets.

d. Add simulation videos / animations on Edmodo

All online learning devices are presented or can be accessed on Edmodo templates by students except Lesson Plan. The function of this lesson plan is as a reference for teachers to carry out teaching and learning activities to be more directed and run effectively [16]. Therefore, the Lesson Plan for Independent Learning is only a guide for teachers and is not distributed on Edmodo for students.

The following is a display of the section of the Online Learning Devices that was created:

![Figure 2 Lesson Plan (RPP) of Independent Learning](image)

![Figure 3 Display Edmodo](image)
Figure 4. Display Handout

Figure 5. Display in the Handout

Figure 6. Display material summary on Handout

Figure 7. Display of the HOTS problem in the Handout
4.1. Expert Validation Results

4.1.1. Results of Expert Validation of material. Material expert validation is used to assess material that has been compiled in PDEODE-based online learning tools on the Doppler Effect material. There are 4 indicators assessed with 14 number of questions which include about: (1) The relevance of the material, (2) The accuracy of the material, (3) The suitability of the presentation with the demands of online learning centered on students, and (4) Writing language. Material expert validators numbered 2 physics lecturers.

The overall percentage of material expert validation was 63.77%. These results indicate that the Doppler Effect material contained in online learning devices is categorized as "Good" so that it can proceed to the trial phase by first making the initial revision as suggested by the material experts.
4.1.2. **Media Expert Validation Results.** Validation conducted by media experts is used to assess PDEODE-based online learning device products on the Doppler effect material. There are 4 indicators with 24 questions including them covers about: (1) display of learning activities in edmodo, (2) LKPD component, (3) Handout component, (4) component video and animated Doppler Effect simulation. Validator of media experts totaled 2 teachers of vocational physics.

The media expert validation questionnaire was distributed to each validator with the help of the Google form. The results and analysis of media validation can be seen in table 4. below:

![Figure 11. Bar chart of media expert validation Results](image)

The overall percentage results of validation of media experts is 89.94%. These results indicate that the media developed is "Very Good" so that it can proceed to the testing phase by revising a few deficiencies than suggested by media experts.

4.1.3. **Learning Expert Validation Results.** Validation conducted by learning experts is used to assess the overall online learning tools on the Doppler Effect material can be applied based on PDEODE stages or not in teaching and learning activities. There are 4 indicators with 24 questions which include about: (1) feasibility of Lesson Plan (RPP), (2) Stages of PDEODE, (3) Characteristics of Handouts, (4) Aspects of evaluation, (5) Characteristics of Student Worksheet (LKPD). The learning expert validators numbered 2 Physics lecturers.

![Figure 12. Bar Chart of Learning Experts Validation Results](image)

The overall percentage results from the validation of learning experts are 85%. These results indicate that the Online Learning Devices developed by the researchers is "Very Good" so that it can proceed to the trial phase by revising a few deficiencies than those suggested by learning experts.
4.1.4. Test Validation Results by Teachers

![Figure 13. Bar chart Test Results of Validation of Trial by Teacher](chart)

Validation The trial was conducted by 3 physics teachers as validators who validated 4 indicators with 20 questions.

The overall percentage results of validation of trials by teachers was 94%. These results indicate that the PDEODE-based Online Learning Tool on the Doppler Effect material was developed "Very Good" so that it can be used as well as possible at home for online learning. But it is clear that the rest of the total percentage obtained is 6%. The researcher tries to revise based on the teacher's suggestion that one of them for the question section presented in the Handout should be made in the form of HOTS questions.

4.1.5. Joint Validation Results Experts and Trials by Teachers

![Figure 14. Bar chart Results of expert validation Results and overall trials](chart)

Based on the results of the development of expert and teacher validation tests as much as 83.18%, it can be concluded that the PDEODE-based online learning device in the Edmodo-assisted Doppler Effect material for Grade X Vocational Schools is declared to have met the criteria of "Very Good" and is feasible. This shows that the online learning tool can be used.
5. Documentation

Figure 15 The teacher gives instructions early

Figure 16 Display the zoom meeting with students

Figure 17 Display of the Handout opened on Edmodo

Figure 18 Video display / simulation on edmodo

Figure 19 Display Interactive discussion through the zoom meeting on the Edmodo display

6. Conclusion

The result shows that the PDEODE based online learning devices is "very good" because it has been through the validation test stage and trial phase with a percentage of achievement as much as 63.77% according to material experts, 89.94% according to media experts and 85% according to learning experts. The results of trials by teachers and participants students show the percentage of teacher responses as much as 94% and overall can be a percentage of 83.18%. Based on the analysis of data
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