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Need Analysis of The Development Discovery Learning-Based Module Assisted by PhET Simulations to Train Students' Conceptual Understanding

Atika Nurul Fathiyah*, Zulfarina, Yennita
Master of Science Education, University of Riau, Pekanbaru, 28293, Indonesia

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A B S T R A C T

Students' conceptual understanding is an essential component in terms of successful learning. But the fact shows that the conceptual understanding of Indonesian students is still relatively low. One of the factors for the unelevated understanding of the concept is the lack of active participation during the process. Student involvement encounter by using teaching materials that facilitate student learning independence. One way is to use a module integrated with discovery learning models that authorize students to learn independently. This research is survey research as an initial step in developing discovery learning-based learning modules assisted by PhET Simulations. The benefit of this research is to find out what students currently need in science learning and how much students need for the buildup of discovery learning-based modules. The subjects used in this study were junior high school students with a sample size of 35 students and 26 science teachers selected by region. The needs analysis includes four indicators, a) analysis of learning problems; b) student analysis; c) objective analysis; and d) learning setting analysis. Based on the results of this study, the discovery learning-based learning modules assisted by PhET Simulations needed to be developed as a science learning medium to train students' conceptual understanding in Riau and Riau Islands provinces.

1. Introduction

Science learning (IPA) in the 2013 curriculum is an integrated process. It intends to provide a direct experience for students to improve their ability to absorb, retain, and apply the concepts they have learned. In this way, students get the knack for discovering a variety of substantial, authentic knowledge through active learning (Kemendikbud, 2018). Science learning should come on stage so that

* Corresponding author.
E-mail: atikafurusawa1412@gmail.com
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students more easily understand the relationship between material concepts. Furthermore, it can also cultivate meaningful learning (Amini, 2017) and equip students to understand concepts extensively (Nie, 2019).

International Mathematical and Scientific Research (TIMSS) in 2015 gave Indonesia a score of 44th out of 49 countries. The average score was 397. This score is far below the international average of 500. Indonesia's achievement in the 2018 International Student Assessment Program (PISA) was ranked 74 out of 79 countries, with a science score of 379. Most of the questions tested in TIMSS and PISA require students to have conceptual understanding, higher reasoning, and process skills. The data shows that the scientific conceptual understanding among Indonesian students is remain subjacent. One of the solutions applied to upbringing to conceptual comprehension is adopting a constructivist learning model. This approach makes students become the main actors in the learning process. Constructivism compels students to disclose various perceptions and formulate their ideas (Papan & Sompong, 2012). They also can explore their knowledge deeper. Constructivist learning is an approach that develops thinking skills through erudition activities (Pande & Bharathi, 2020).

Discovery learning is a learning model developed based on constructivism (Anyafulude, 2013). This model seeks to produce meaningful learning and proclaims to allow and encourage students to acquire knowledge and skills (Deswila, 2020). Discovery learning helps students discover and learn scientific concepts by actively participating in the learning process. However, in this discovery process, the schoolteacher guides the students to be more focused and fully able to achieve the process and learning objectives. Students also play an active part in the learning process by answering various questions and solving problems to attain concepts (Lee, 2013). The stages of discovery learning describe in Table 1.

Table 1. The stages of Discovery Learning Model

No	Stages	Teacher's Activities
1	*Stimulation*	Teacher starts the teaching and learning process by questioning.
2	Problem Statement	Teachers provide opportunities for students to identify as many relevant problems as possible.
3	Data Collection	Teachers provide opportunities for students to collect as much relevant information as possible to prove if the hypothesis is legitimate.
4	Data Processing	All information from readings, interviews, observations, etcetera is then processed randomly, classified, tabulated, calculated in various ways, and interpreted at a certain level of confidence.
5	Verification	Teacher guides students to execute careful examinations to prove whether the hypothesis set earlier is correct based on the outcome of data processing.
6	Generalization	Teacher and students conclude general principles and then applied to all the same incidents or problems by considering the verification results.

The use of learning models must consider the class needs characteristics of learners, and subjects (Buchori, 2017), E. Smaldino (2018) states that learning will be able to have an impact on overall understanding if implemented through meaningful learning. The application of the discovery learning model induces a significant contribution to students' thinking skills (Fuad, 2017). In addition to applying the learning model, learning accomplishment also profoundly depends on the tools and teaching materials used. The module is one of the elements to accommodate students to learn independently with or without teacher guidance (Puspitasari, 2019). The appliance of modules at the orientation stage of learning enhances the effectiveness of the learning process and the delivery of messages and materials (Denanda, 2017).

Adversity in experiments and direct observations can evoke difficulties in understanding concepts. The limitations of the human senses in observing phenomena lead to inaccurate conceptual comprehension (Rifqa, 2016). Abstruse concepts are hard to visualize or directly show the process even though actual laboratory activities are performed (Hermansyah, 2017). For this reason, the media needs to bolster presenting abstract phenomena to be more realistic. PhET simulations are deliberately appropriate to implement due to have proven effective in facilitating and explaining science lessons, providing legitimate examples in everyday life, and solving science problems (Nurahman, 2019). PhET simulation encourages students to understand abstract phenomena excessively (Sari & Simanjuntak, 2016).

The results from various studies show that the Virtual PhET Lab helps students understand physics concepts (Diraya, 2021). Many previous studies have shown that the use of media for PhET simulations has an impact on learning. According to research completed by Saputra W (2019), PhET simulation media increases students' interest in science and learning process skills. Khairunnisak (2018) declared that PhET simulation assists junior high school students with better scientific conceptual comprehension of hydraulic materials. Research by Nurul Hidayah (2020) states that the applications of PhET simulation media can increase high school student understanding of the physics concept of elastic materials.

Based on the explanation of the importance of teaching materials, learning media, and models to improve students' conceptual understanding. Development of teaching materials in PhET Simulations-assisted discovery learning-based modules to train students' conceptual understanding is necessary. A preliminary analysis needs to complete to assess the urgency of module development. The needs analysis is obligatory to complete because it aims to produce teaching materials that suit the characteristics and conditions of learners. The needs analysis includes four indicators which are (1) learning analysis; (2) student analysis; (3) analysis of learning objectives; and (4) analysis of learning settings (Teguh & Made, 2014).

2. Methodology

This research is survey research involving 35 junior high school students and 26 junior high school science teachers. The sampling technique used in this study is cluster sampling procedures or sampling based on particular areas. The sampling technique is based on a predetermined population area to determine which population will use as a data source. The research procedure will be conducted through the scheme in Figure 1.

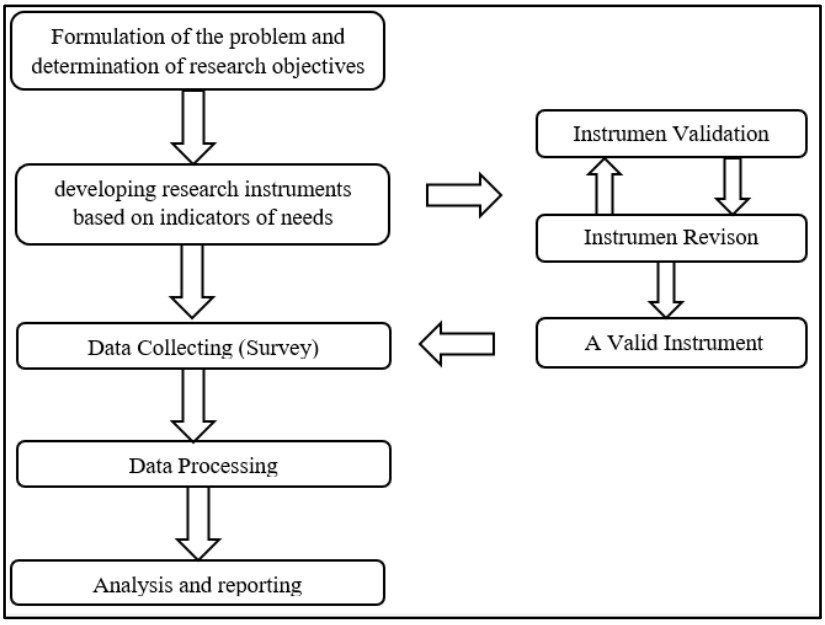

Figure 1. Reseach's scheme

The research instrument used was a closed questionnaire developed based on an analysis of learning needs. The developed questionnaire consists of 4 indicators, 19 items written for students and 22 for teachers. The indicators of the research instrument are shown in Table 2.

Table 2. Indicators of Student and Teacher Needs Questionnaire

Indicators	Amout of Questions (Student)	Amout of Questions (Teacher)
Analysis of Learning Problems	7	8
Analysis of Learning Objectives	5	5
Student Analysis	4	5
Learning Setting Analysis	3	4

Source : (Teguh & Made, 2014).

Question items in Table 2 consist of 4 choices (strongly agree score 4, agree score 3, disagree score 2, and strongly disagree score 1). Before the questionnaire was distributed to students, construct validation was accomplished by two science experts. If the expert has stated that this instrument is valid, it implies that the survey instrument is qualified to be disseminated. Data from the necessity

questionnaire were analyzed using descriptive statistics in particular averages and percentages. Determining the level of need for the development of discovery learning-based modules assisted by PhET Simulations for each indicator is determined by the assessment criteria contained in Table 3 below.

Table 3. Product Development Needs Category Levels

No	Mean	Category	Decision
1	>3,25 - 4	Very High	Needed
2	> 2,5 - ≤ 3,25	High	Needed
3	> 1,75 - ≤ 2,5	Low	Unneeded
4	1 - ≤ 1,75	Very Low	Unneeded

Source : (Afni & Kazmi, 2019)

3. Results and Discussion

Based on data analysis in research. The results of the needs analysis for module development based on discovery learning assisted by PhET Simulations for each indicator feature in Figure 2

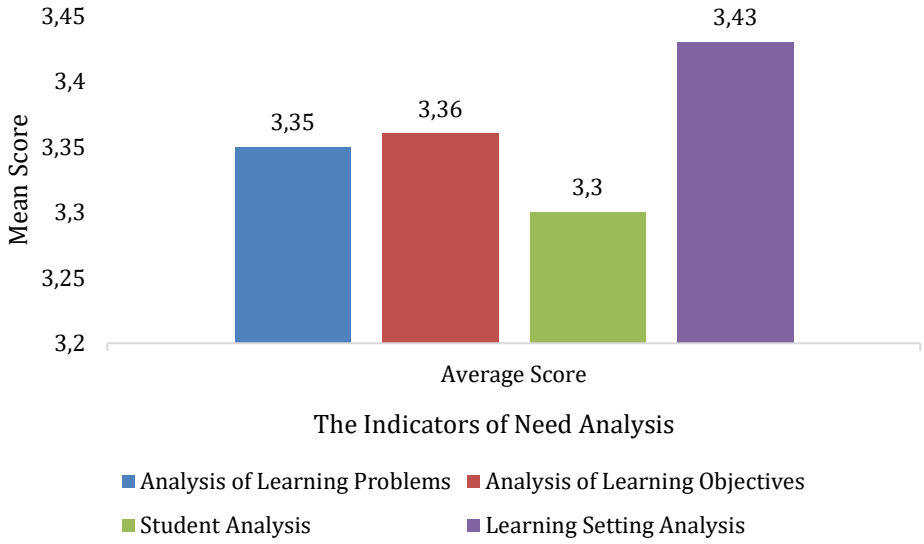

Figure 2. Results of the Needs Analysis for the Development of Discovery Learning Modules assisted by PhET Simulations by Students

Needs analysis is one of the ways to identify solutions to learning problems. Asrizal (2017) states that it is crucial to have efforts to fix learning problems to prevent learning gaps. Figure 1 above shows that the average range of scores answered by students is 3.3-3.43. It means that students agree with positive statements about the necessity to develop discovery learning modules assisted by PhET Simulations in learning science. Indicator analysis of the learning problem spotted that the students experienced difficulties in understanding science lessons. The student merely tended to memorize without understanding the meaning. In

addition, the learners covey that they were not interested in learning only theoretical explanations without problem-solving and self-discovery activities. Some students prefer to find and solve a problem single-handedly (Prastiwi & Nurita, 2016). Students relish participating in learning that involves them actively, such as experimenting with the intention that the learning process is not only centered on the teacher.

Furthermore, the analysis of learning objectives needs to be done early before designing learning media. It helps to establish the learning objectives that will be achieved. In particular, the analysis of learning objectives is to determine the purpose of learning orientation in terms of concepts, procedures, and theories (Peniati et al., 2013). The main hope of Science Learning is to create students who are active in building their knowledge and can use their reasoning to comprehend and solve the problems they deal with (Kemendikbud, 2018). Based on Figure 2, it can be seen that this indicator obtained a score of 3.36 which means that students strongly agree with the positive questions given.

Analysis of student needs is requisite in the learning process. the investigation is pivotal to analyzing the appropriate learning components for the learners to embody science learning objectives. Good assessment refers to the cognitive domain and requires an assessment that can measure student abilities (Widiana, 2016). Learner analysis must attain in learning. The learning process should require students' involvement in learning activities where teachers can utilize existing technology (Syaifulloh 2014). The learning media expected by students are media that use learning resources that are varied, interesting, and able to explain science concepts following phenomena in everyday life.

The score obtained from the student analysis indicator is 3.3, which means that the use of attractive media is prominent in exercising their learning understanding. Martinez (2011) states that computer simulations can create a learning process that is much more efficient and can be applied to real-world problems or situations, to improve students' mastery of concepts. PhET Simulations can emphasize the correspondence between actual phenomena and computer simulations by presenting physical models that can be inferred by the students (Destini, 2019).

Based on the graph above, the average range of scores answered by students for analysis of the learning setting is 3.43, indicating the need for learning that emphasizes the discovery process and active participation of students to make students more challenged, motivated, and independent. Concerning the implementation of the 2013 curriculum, learning affirms creating a challenging and motivating learning model so that students are trained to pursue information (Kemendikbud, 2018).

Furthermore, the results of data analysis on distributing questionnaires to 26 science teachers in the provinces of Riau and the Riau Islands can be seen in Figure 3 below:

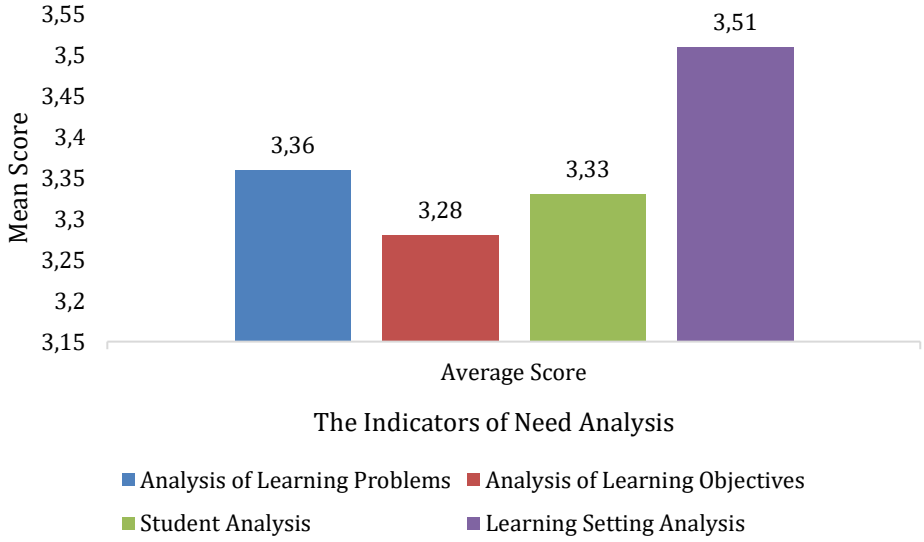

Figure 3. Results of the Needs Analysis for the Development of Discovery Learning Modules assisted by PhET Simulations by the Teacher

Simulations-assisted discovery learning modules is in the range of an average score of 3.28 – 3.51. This data shows that the teacher agrees with the positive statements outlined in the questionnaire items for the necessary development of discovery learning module needs with the help of PhET Simulations. At school, the teacher is one of the main determining factors in improving the quality of education through the learning process (Suwardi & Farnisa, 2018). Teachers are all those empowered and responsible for instructing and supporting students individually and traditionally, both within and outside school. The declaration implies that teachers are professionals with professional obligations in the teaching and learning process. The teacher's role as a facilitator is to provide the availability of facilities to facilitate student learning activities (Saharuddin & Wahab, 2019).

The analysis of the indicators of learning problems obtained an average score of 3.36, which means that according to the teacher's perception, students' conceptual understanding is still relatively hesitant because learners still have difficulty connecting new material concepts with material concepts they already had. The teacher offers a positive response to the statement that students were not interested in learning that did not involve students actively. The learning process should be constructed in the form of student-centered learning.

Analysis of learning objectives obtained an average score of 3.28. This score means that the average teacher agrees with positive statements on the questionnaire items. One of the statement items for this indicator is that the teacher concurs that learning should encourage students to find and solve problems independently. Following KI (Core Competence) 4, students must be able to try, process, and present in a concrete realm to solve problems in science learning. The main hope in learning science is that students are engaged in building their knowledge and can use their reasoning to understand and solve the

problems they face (Kemendikbud, 2018). But in fact, the current learning remains not optimal because the teacher is still becoming the subject of the learning process instead of the students. This fact upholds by the teacher's negative response to the statement that the current learning has been able to make students active in building their knowledge.

The following analysis is an analysis of students' problems. This analysis aims to determine the disputes experienced by students in carrying out learning activities corresponding to the teacher's opinion. According to the teacher, students still experience difficulties in understanding a material concept. The complex happens because some of the material in science learning is transcendental. The abstract idea is hard to visualize or display directly, even through laboratory activities (Hermansyah, 2017). Hence, media is needed to help the process of presenting abstract things become more substantial. This fact is strenghten by the results obtained by an average score of 3.3. This score indicates that the teacher agrees with the positive statement that some science materials require simulation media to explain abstract material concepts, one of which is by using PhET Simulations.

Most studies show that using PhET is more effective than using a real lab, but other studies also show no difference in effectiveness from using PhET compared to a real lab (Astalini, 2019). However, that can reduce the time needed in activities related to technical laboratory work and manual activities, which allows students to spend more time thinking, analyzing, and discussing. To some extent, utilizing PhET media combined with real-world experiments is utterly appropriate. PhET provides a convenient setting for the concept. Apart from that, PhET is a suitable alternative to an actual laboratory. According to Zacharia (2014), simulation can adequately replace real-world experimental equipment under the right conditions.

In the analysis of learning settings, an average score of 3.51 is obtained, which means it is in a very high category and needs improvement in science learning settings. Implementation of the 2013 Curriculum learning emphasizes learning models that are interactive, inspiring, fun, and challenging, motivating students to actively seek information in solving problems (Kemendikbud, 2018). For this reason, an appropriate learning model is required, one of which is discovery learning. According to (John & Ganiu, 2016), the discovery learning model is an activity to find the truth through individual experience. Discovery activity can aim to find a concept and solve problems. Discovery learning is a series of learning activities that optimally involve all students' abilities to seek and investigate systematically, critically, and logically so that they can find their knowledge, attitudes, and skills as a form of behavior change (Huang et al., 2015).

4. Conclusion

The needs analysis carried out to develop the module is assessed based on four indicators: Analysis of learning problems, analysis of learning objectives, student analysis, and learning setting analysis. Based on this study, the development PhET

Simulation-assisted Discovery Learning-based module is necessary to train students' conceptual understanding.

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