The characteristics of development teachers’ pedagogy competencies of electromagnetics test

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Abstract. The aim of this research was to evaluate the faces of the pedagogy competencies test and quantity mistakes rendering to classical test theory and item response theory. The test was constructed on the fundamental concepts and essential content of the electromagnetics, with an orientation to the pedagogy competencies physics teacher. The pedagogy competencies designate is the competencies integrated into teaching and learning electromagnetic. The research method is a mixed-method with embedded experimental models. The analysis was based on 40 answers of pre-service who have taken training teaching in school (PPL) courses at the Physics Education Department. Based on classical test theory indicates that 15 test items were analyzed, 12 items were good quality with reliability index is 0.72. As of information function and standard error measurement of item response theory, the conclusion of this evaluation is that the model 3PL is better to use when evaluating the test.

1. Introduction

The teacher is one of the most important components in learning activities because teachers are people who directly deal with students in the implementation of learning activities. Therefore, according to “Peraturan Pemerintah Republik Indonesia No. 74 Year 2008” about the teachers, states some requirements that must be possessed by a professional teacher, that is an academic qualification, competence, certificate of educator, healthy physically and spiritually, and have the ability to realize national education goal [1]. Teacher competence is a set of knowledge, skills, and behavior that must be owned, experienced, mastered and actualized by teachers in performing professional duties. The competence of physics teachers includes knowledge of physical content, the procedures of physics teaching, and the skills necessary to carry out learning tasks such as mathematical mastery, educational technology that used for the study of physics, the internet and various other skills that support learning activities and can actualize the various skills in physics learning activities. A competent teacher will carry out the task of teaching well and full of responsibility.

In order to realize the competent teacher, the government has stipulated “Peraturan Pemerintah Republik Indonesia No. 74 Year 2008” about teachers, stated that there are four competencies that must be possessed by teachers they are pedagogy competencies, personality competencies, social competences and professional competencies that obtained through professional education which is a
unity that supports each other and not separated from each other [1]. Based on the “Undang-Undang No. 14 Year 2005” about teachers and lecturers, pedagogy competencies are the ability to manage students learning. Further explanation of pedagogy competencies in “Peraturan Menteri Pendidikan Nasional No. 16 Year 2007” about academic qualification and teachers’ competencies which explains that teacher’s pedagogy competencies include: mastering learning theories and learning principles that educate, developing curriculum related to the subjects being taught, organizing learning that educates, and utilizing the technology of information and communication for the value of learning [2 -3].

The basic competence that must be possessed in pedagogy competencies is to apply various approaches, strategies, methods, and instructional techniques related to the subjects being taught. The use of appropriate approaches, strategies, methods, and learning techniques will have a positive impact on students there are increased learning outcomes, avoidance of learning saturation and increased student learning interest. By mastering various approaches, strategies, methods, and techniques of learning, teachers can apply it in accordance with the characteristics of learning materials. Abstract concepts can be demonstrated by using visuals in the form of video or using direct learning by demonstration method to show the effect of electric current passing the conductor against the compass needle.

In the globalization era, the teachers are required to utilize the technology of information and communication for the determinations of learning in accordance with “Peraturan Menteri Pendidikan Nasional No. 16 Year 2007” [3]. Through using the technology of information and communication allows learners can access the learning materials at any time and repeat as needed, obtain information from various sources and communicate with the teachers or lecturers at all times in accordance with the demands of their needs.

The use of technology of information and communication in physics learning can help students to explain abstract concepts. Some concepts are the basis of electric and magnetic concepts are abstract, such as the transfer of electrons from one object to another object, the electric field line, the magnitude of the field caused by the electrical charge and so on. Explanations of these concepts through discourses and visualization of images such as those found in textbooks or school books are quite effectively understood by students [4-6]. However, some students still need further explanation to understand the abstract concepts so that teachers need to use other media, such as video, animation, and simulation to explain the concept [7].

Development of pedagogy competencies through e-learning tutorials can involve participants directly in the use of e-learning so that it becomes a learning experience for the participants. By using e-learning the teachers can search for various learning resources, share the difficulties encountered in the task, and share methods of solving learning problems aimed at improving student learning outcomes. Therefore, in an effort to improve the pedagogy competencies of teachers, in particular, can use the technology of information and communication in learning by using e-learning is one of the best methods because participants are directly involved in learning.

This research aims to analyse the characteristics of pedagogy competences test according to classical test theory and item response theory. Analysis of classical test theory is to determine standard deviation, reliability, distinguishing power and difficulty level. Analysis with item response theory is through item characteristic curve, information function, and standard deviation measurement. The test form is a multiple choice with five options that include electric magnetic material. Indicators of pedagogy competences test based on the “Peraturan Menteri Pendidikan Nasional N. 16 Year 2007”. However, in this study only four out of ten indicators will be tested because the indicators are related to electric and magnetic content. There are fifteen questions of pedagogy competencies with difficulty level based on relationships with other concepts and do not consider the use of special mathematics and enrichment material. The basic concepts and key principles are examined by three experts, and the results of the judgment become input for revision. The test grilles are arranged in Table 1.
Table 1. The test grilles of pedagogy competences

| Basic Concepts or Essential Principles                                      | Sub Pedagogy Competences               |
|-----------------------------------------------------------------------------|----------------------------------------|
| Static Electric: Electrical Displacement, Electric Field Lines, Electrical  |
| Potential and Electric Force                                               |
| Dynamic Electric                                                           |
| Electric and Magnetic                                                      |

2. Methods

The research method used research and development [8]. The test consists of fifteen questions for multiple choices with five answer options. A total of 40 students in physics majors participated in this research. Participants are seventh-semester students who have passed electric and magnetic course and PPL courses in the academic year 2017-2018. Data analysis aims to establish the validity of the instrument by using classical theory and response theory. This research is part of adaptive e-learning development research to improve the pedagogy competences and professional competencies of teachers.

The primary research, collecting data are difficult obtained from field study, literature study, and journal analysis and synthesis. We excavation the preliminary information of pedagogy competencies teachers through data that obtained from P4TK results from UKG 2014, especially on physics subjects in Palembang City. Intervention in the form of a questionnaire to determine the factors that cause the electric and magnetic material is difficult for teachers (qual during intervention). After the intervention, the development of pedagogy competences test was evaluated on quan post measure with classical test theory and item response theory. The results analysis during the intervention became inputs to improve the quality of the electric and magnetic pedagogy competences test (qual after intervention). After the whole series of stages has been completed, then we analysed and interpreted on interpretation based on quan (qual) result with classical test theory and item response theory. The material electricity and magnetism arrange according to multimode representation [9].

Analysis of classical item theory is to determine standard deviation, reliability with KR-20, distinguishing power with biserial point correlation coefficient (rpbis), and difficulty level (p) with the average of the correct answer. The item response theory is a method for a test item based on the individual's ability (latent trait) of a test participant, not on the basis of the group's ability as in the classical test theory. The types of item response theory depend on the parameters used is one parameter logistics model (1PL), two parameters (2PL) and three parameters (3PL). The respective equations of the three models are as follows [10-12],

\[
P_{i}(\theta) = \frac{e^{\theta-b_i}}{1 + e^{\theta-b_i}} \quad (1)
\]

\[
P_{i}(\theta) = \frac{e^{Da_i(\theta-b_i)}}{1 + e^{Da_i(\theta-b_i)}} \quad (2)
\]

\[
P_{i}(\theta) = c_i + (1 - c_i) \frac{e^{Da_i(\theta-b_i)}}{1 + e^{Da_i(\theta-b_i)}} \quad (3)
\]

with:

- \(P_{i}(\theta)\): the probability of a participant with the ability \(\theta\) who can answer the item for \(i\) correctly
- \(\theta\): the ability level of participants
- \(D\): scaling factor that costs 1.7
- \(a_i\): distinguishing power item for \(i\)
- \(b_i\): difficulty level item for \(i\)
- \(c_i\): queer guess factor item for \(i\)
- \(i\): 1, 2, 3 ... \(n\)
- \(n\): number of items in test
3. Result and Discussion

3.1 Qualitative data
Qualitative data consists of basic concepts, essential principles of electric and magnetic, and the results of expert’s judgment. Aspects are assessed by experts as in Table 2.

| Table 2. Aspects of test that assessed by experts |
|-----------------------------------------------|
| A. Material                                    |
| 1. Test according to the indicator             |
| 2. The material in question according to competences |
| 3. Choice answers are homogeneous and logic    |
| 4. There is only one answer key                 |
| B. Construction                                |
| 5. The test is formulated briefly, clearly, and firmly |
| 6. Test and answer options are only necessary statements |
| 7. The test does not provide a clue key answer |
| 8. The test is free of double negative statements |
| 9. Choice answers are homogeneous and logic in terms of material |
| 10. Pictures, graphs, tables, diagrams, or the like are clear and functional |
| 11. The length of the choice answers are relatively same |
| 12. The choice answers of numerical are arranged from a large order to a small or vice versa |
| 13. Test items do not depend on previous test answers |

3.2 Classic Test Theory
Test instrument has the standard deviation of 3.5, reliability KR-20 of 0.72, and standard error measurement of 1.676. The rpbis distinguishing power ranges from 0.48 to 0.68, and the difficulty level ranges from 0.32 to 0.66. The level of difficulty (p) is grouped into difficult (p ≤ 0.3), moderate (0.7 > p > 0.3), and easy (p > 0.7). Referring to good test items have rpbis ≥ 0.4, based on the results of the classic test show that all valid and can be used. So, all of the questions can be used for pedagogy competences test in adaptive e-learning tutorial. From the correlation matrix between items, we get the eigen value graph for the total number of components as shown in Figure 2.

![Scree Plot](image)

**Figure 1.** Eigen values of factor analysis
There are five eigen values that are greater than one. Components are to the one dominant and able to explain the variant of the test response data of 32.53%. This confirms unidimensional as a requirement model of the theory response item [13,14]. From Figure 3, there is no relationship between the levels of difficulty with the distinguishing power item of the item. This means that the level of difficulty and distinguishing power of items have a great chance to be involved in the selected model. Thus, the 2PL or 3PL model is a more rational alternative choice than the 1PL model. By using the software “eirt” version 1.3.0, we obtained parameters for each logistics model.

The information of each model is explained through the information function (IF), which gives a clue as to the extent to which the selected model (1PL, 2PL, or 3PL) is able to provide information about traits-level estimation along the scale of capability. The higher the IF peak is the more informative the selected model able to explain the abilities of the participants. In mathematically, the item information function (IF) is expressed by the equation as follows.

\[
IF_i(\theta) = \frac{(p'_i(\theta))^2}{p_i(\theta)(1-p_i(\theta))}
\]

The function of total item information in mathematical formula is:

\[
TI(\theta) = \sum IF_i(\theta)
\]

For each IRT model, the information function of the pedagogy competences test is shown in Figure 3.

![Figure 2](image.png)

**Figure 2.** The function of information 1PL, 2PL, and 3PL.

From Figure 3 can be seen that the function of information the 3PL model has the highest peak. This means that the 3PL model can provide better information about the relationship between the response patterns of the participants and the overall characteristics of each item. This also implies the precision of the testers' ability to estimate; the higher function of information is the more precise a model can be in estimating the ability of the participants. From the analysis of classical item theory
shows that electric and magnetic pedagogy competences test has internal reliability about 0.73. The level of difficulty extends from 0.48 to 0.68 and the distinguishing power from 0.32 to 0.66. The test can differentiate between the low and high group and the distractors work well.

4. Conclusion
From the analysis of item response theory obtained the most rational logistic parameter model is the 3PL model. There was a positive linear correlation between the distinguishing power (rpbris) and the parameter a 3PL, and the negative linear correlation between the level of difficulty (p) with the parameter a 2PL, and the negative linear correlation between the level of difficulty (p) and the b parameter of 2PL.

5. References
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