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by Ida8 Hamidah8

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The Use of Classroom Assessment to Explore Problem Solving Skills Based on Pre-Service Teachers' Cognitive Style Dimension in Basic Physics Course

Rahmawati^{1,2*}, Nuryani Y. Rustaman², Ida Hamidah², Dadi Rusdiana²

¹Universitas Muhammadiyah Makassar, Jl. Sultan Alauddin No. 259, Makassar 90222, Indonesia

²Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

Email: rahmawati.syamsuddin@yahoo.co.id

Abstract. The aim of this study was to explore the use of assessment strategy which can measure problem solving skills of pre-service teachers based on their cognitive style in basic physics course. The sample consisted of 95 persons (male = 15, female = 75). This study used an exploratory research with observation techniques by interview, questionnaire, and test. The results indicated that the lecturer only used *paper-pencil test* assessment strategy to measure pre-service teachers' achievement and also used conventional learning strategy. It means that the lecturer did not measure pre-services' thinking process in learning, like problem solving skills. One of the factors which can influence student problem solving skills is cognitive style as an internal factor. Field Dependent (FD) and Field Independent (FI) are two cognitive styles which were measured with using Group Embedded Figure Test (GEFT) test. The result showed that 82% of pre-service teachers were FD cognitive style and only 18% of pre-service teachers had FI cognitive style. Furthermore, these findings became the fundamental design to develop a problem solving assessment model to measure pre-service teachers' problem solving skills and process in basic physics course.

1. Introduction

Assessment is systematic and varied process to get more information data and interpret it as a feedback in learning [1]. Furthermore, assessment strategy can help teacher to monitor student learning progress and help to improve learning process so that it is important to use relevant assessment [2]. In learning science, assessment should measure knowledge and concepts, science process skills, and higher-order thinking skills (like problem solving, critical thinking, logical thinking, and creative thinking skills) and use portfolio assessment and performance assessment for science process skills and scientific performance in learning science [3]. There is a problem in the field that many teachers or lecturers hope that their students can think critically and solve problems, but they just do not know how to design and implement assessment strategy of problem solving.

Problem solving is one of the activities using thinking process. Every student can be different between one to another in problem solving process. It could be caused by internal and external factors. Indeed, internal factor is related cognitive psychology, exactly cognitive style dimension [4]. The concept of cognitive style is closely connected to the idea of psychological differentiation [5]. It means that differences exist among individuals in relation with their cognitive structure and psychological



1 function, the other name is called 'psychological individuality' [6]. The fundamental differences between individual FI and FD cognitive style can be observed to individual characteristics related to process information. Basically, FI persons perceive and process information analytically, while FD persons do it in global, holistic, and passive way [5]. Furthermore, FD persons have difficulty in separating an item from its context while FI persons can easily break up an organized field and separate relevant information from its context or discern 'signal' (what matter) from 'noise' (the incidental and peripheral) in confusing background. [6]. Finding of previous studies indicated that there are relationship between cognitive style and problem-solving skills of pre-service teachers to some learning materials, in particular the topic of mechanics basic concepts [5]. Result of that study showed pre-service teachers' problem-solving skills were statistically related to their FI/FD cognitive style. Based on finding of some previous studies, it means that cognitive style of persons have relationship with their problem-solving process, so that it is important to facilitate learners' thinking process in learning, like problem-solving skills. The effort that can be done to develop learners' problem-solving skills is by using learning strategy or assessment strategy because assessment is closely related to learning process. Using assessment strategy is formal effort to take more information related to knowledge, skills, and attitude of students as information for teachers to make a decision to improve learning process and student achievement [7].

This paper tried to explore the use of classroom assessment in basic physics course. In addition, GEFT test was administered to indicate FI/FD tendency of students. The findings of this study will be basic to develop assessment problem solving model related to student cognitive style.

2. Methodology

The type of this study was an exploratory research with observation techniques by interview, and questioners to pre-service teachers and lecturer. Subjects was 95 freshmen (male = 15, and female = 75) who have taken basic physics course in the first year 2015/2016. The students ranged in age from 18 to 21 years.

The instruments used in this research were questionnaire and GEFT test. Questionnaire was numerical rating scale that consisted of two aspects. Each aspect consisted of some statements about the important of problem-solving skills for students, and the assessment strategy used by lecturer in basic physics course. Observational techniques used in instruments were numerical rating scale for the first aspect. It consisted of strongly agree (SA), agree (A), cannot select (CS), disagree (DA), and strongly disagree (SD). In addition, the second aspect used technique of checklists with yes, cannot select, and no. After obtained data, those data was processed into percentage and then analyse data into qualitative and quantitative description. The instrument questionnaires were administered to subjects and the lecturer to obtain information about the use of classroom assessment and learning strategy in basic physics course.

Furthermore, test technique was used to measure cognitive style of pre-service teachers with using "Group Embedded Figure Test (GEFT)" instrument. GEFT is a psychometric measure whose reliability and validity has been supported by a growing body of studies. They are Salih *et al* [5], Herman *et al* [6], Reza *et al* [8], and Mohammad *et al* [9]. It consists of three sections; each section has simple figure embedded in large complex figures, which had to be traced. This instrument was administered to students. The first section which has a time limit of 2 minutes includes 7 items. This section is only as a warm-up to make them ready but the items in this section were not included in the total score. The real task began at the second section and into the third one. The second and the third section included a total of 18 items, 9 items for each section, which had to be traced in 12 minutes set within time limit of 6 minutes for each. These sections were given score 0 for the false answers and score 1 for the true answers so that the maximal score is 18 and the minimum is 0. After the second section had been administered, students stopped for more instruction on the third section and then went on. Those whose score above 12 out of 18 were labelled FI persons and those with score of 11 and less than 11 were branded as FD cognitive stylists.

3. Results and Discussions

3.1. Description about cognitive style of pre-service teachers

Figure 1 showed that the score of the participants related with cognitive style of pre-service teachers. GEFT score was ranged from 0 to 16. Dominant scores which were obtained by students were score 4, 8, and 9. The analysis model of Howard and Laura [9] describes that persons who get scores between 0 and 11 are labeled FD cognitive stylist and they who get score more 11 until maximum score are called FI persons. From this analysis model, it can be explained that there were 78 students (82%) who get score in the range 0 – 11 as FD person. While they who get score 12 to 18 were 17 persons (18%) as FI.

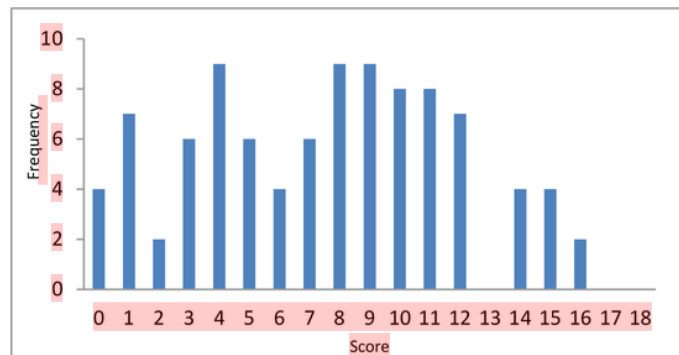


Figure 1. Distribution of student scores to GEFT test

Analysis result about obtaining test score of GEFT showed that the number of students who had FD cognitive style was more than the number of students with FI cognitive style. Based on this result, we can conclude that every student has cognitive style to get and process more information in the class. Therefore, it is important to consider the use of appropriate assessment and learning strategy with our student characteristic.

3.2. Description of questionnaire data analysis

Questionnaire instrument which were administered to pre-service teachers and lecturer aims to explore more information about assessment used by lecturer in basic physics course. These questionnaires consisted of two aspects. They were about the important of problem solving skills and assessment strategy used by lecturer. There are more statements used in the instruments which are showed by table 1 below.

Table 1. Statements used in the instrument to explore more information about the use of assessment and learning strategy

Aspects	Statements
The important of developing problem solving skills	1. Developing higher order thinking skills, like problem-solving skills, is an essential aspect for pre-service teachers
	2. Developing problem-solving skills will add the load task for students
	3. Developing problem-solving skills in basic physics course will spend more time
	4. Problem-solving skills is needed by pre-service teachers
	5. Every student who has characteristic can influence problem-solving

Table 1. Statements used in the instrument to explore more information about the use of assessment and learning strategy

Aspects	Statements
	skills of persons
	6. It needs to habits for improving problem-solving skills
	7. I am usually and able to solve problems
	8. My problem solving skills depend on complexity of contexts
	9. My problem solving skills depend on the situation of my feeling
	10. My problem solving skills depend on the class situation
	11. Problem solving skills should be implemented in the all courses, specific in basic physics course
	12. Problem solving skills of pre-service teachers should be assessed for learning in the classroom
Assessment strategy used to develop thinking process of pre-service teachers	1. Do the kinds of tasks given by lecturer improve your thinking skills?
	2. Do your tasks given by lecturer obtain feedback?
	3. Does the assessment strategy by lecturer able to develop your thinking process?
	4. Does the lecturer assess your task orientated to develop your problem solving skills?
	5. Are your individual task and group task considered to obtain score in the final score?
	6. Do you know about the assessment strategy used by lecturer?
	7. Can your tasks help you to develop your thinking ability?
	8. Does your lecturer assess your tasks oriented to develop thinking process?
	9. Are you satisfied to your final score in basic physics course?
	10. Do you hope to get comprehensive and continue assessment of your tasks?

The result of analysis from table 1 was presented into the figure 2 and 3 below. Figure 2 indicated about the student expectation to develop their problem solving skills by using appropriate assessment strategy of lecturer. It is important for them who will face more problems in their life. Therefore, pre-service teachers thought that problem solving skills was necessary to be tried by learning and assessment strategy.

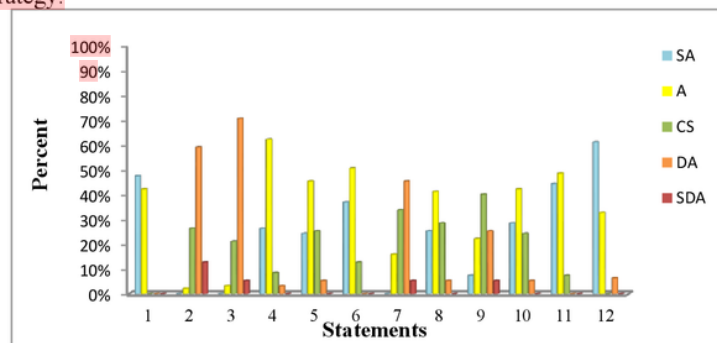


Figure 2. Percentage of student response to aspects of the important of developing problem solving skills in basic physics course

The explanation of above statement can be supported by figure 3. Figure 3 showed that there are some statements of students which indicated problem solving process has not been facilitated by lecturer in basic physics course. Furthermore, the authors claimed that lecturer in basic physics course still used summative assessment. There is no specific assessment model to measure problem solving process based on student cognitive style. Until now, the lecture only used assessment strategy which focused to student achievement using paper and pencil tests, like middle and final exam. In addition, the use of assessment strategy has not been able to support development of student problem solving skills even though problem solving skills can be trained gradually [11].

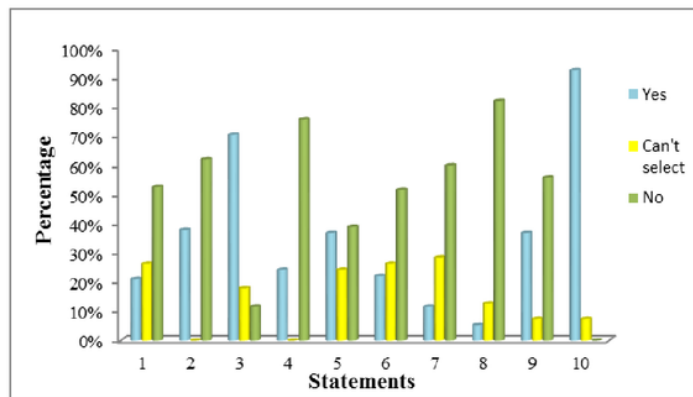


Figure 3. Percentage of student response to aspects of the use of assessment strategy by lecturer to develop thinking process in basic physics course

The effect of applying assessment strategy and learning model in basic physics course was that students felt difficult to solve problems when they faced to complex problems in basic physics course so that this situation made them have gotten low achievement (in grade A only 6% students, B = 26% students, C = 39% students, D = 12% student, and E = 12% students). From this statement, this is basic to design model of problem solving assessment with considering student cognitive style aspect so that this model can measure problem-solving process. In addition, it is effort to improve learning process and assessment strategy in other course.

4. Conclusions

Based on the result study, it can be concluded that using assessment strategy by lecturer has not been appropriate to develop problem-solving skills of students and did not consider psychology cognitive style of students in implementing assessment strategy. Even though, every student has the characteristic of individual cognitive style. The number of students with FD cognitive style more than FI cognitive style persons so that it is important to consider cognitive style variable in basic physics course. The effect of lecturer behavior was students have not been able to indicate their thinking process skills, specifically in problem solving process. In addition, this problem becomes the fundamental of designing model of problem solving assessment.

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