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Formative assessment of fruitful criteria in physics learning based on pedagogy subject matter approach

Y Suhendi^{1*}, M R Aulia¹, D Kuntadi¹, D Mulhayatiah¹, D Nasrudin¹, A Malik¹ and R Ardiansyah²

¹Program Studi Pendidikan Fisika, UIN Sunan Gunung Djati Bandung, Jl. A.H. Nasution No. 105, Bandung 40154, Indonesia

²Pendidikan Biologi, Universitas Siliwangi, Jalan Siliwangi No.24, Tasikmalaya 46115, Indonesia

*herni.suhendi@uinsgd.ac.id

Abstract. Student knowledge criteria is one aspect that shows the success of a learning process. According to pedagogy subject matter, learning is successful if the students' knowledge has reached the fruitful criteria. This research aims to determine the formative assessment of fruitful criteria in work and energy learning based on directing motives and syntactic aspects. The research method used is qualitative with a case study approach. Data were analyzed using discourse analysis. Sample of this research are teacher and students at one school in the Bandung district was conducted on the teaching motives of educators, aspects of teaching materials and formative assessment used in learning activities with data collection techniques in the form of direct and indirect observation using a video recorder with an observation sheet and indicator motives, aspects and criteria sheet. The analysis is done by making a transcript of learning activities, making basic texts with refinement, preparing micro and macro propositions so that the learning macro structure is obtained. Furthermore, the analysis is carried out with reference to the indicators of each motif, aspect, and criteria. The results showed there were six formative assessment questions of fruitful criteria based on directing motives and syntactic aspects or appears at 37.5% of the total fruitful criteria formative assessment. The researcher suggests doing research on other criteria so that it can be known in full the types of questions for formative assessment based on the pedagogy subject matter approach

1. Introduction

One of the main objectives of the physics learning process is the achievement of good understanding or knowledge by students so that later it can be used to answer various kinds of problems and explain various physical phenomena [1]. According to the pedagogy subject matter view, students' knowledge is divided into three namely intelligible, usable, and fruitful [2]. Palisoa revealed that the criteria for fruitful knowledge are being able to see the extent to which students are able to use concepts that have been learned against problem solving [3]. So, the physics learning objectives will be achieved when the students' knowledge is at the fruitful criteria.

Fruitful knowledge criteria for students can be built by educators through teaching materials that contain syntactical aspects which are intellectual skills, which play a role in building knowledge using laws, rules, theories, etc. and provide learning by using the directing motif that is directing students so that they can solve the given problems [4]. While the achievement of students' fruitful knowledge criteria can be known through assessments conducted or given by educators. Educators can make formative assessments to measure the fruitful criteria of students so that they can immediately know the criteria of



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students' knowledge of the concepts being taught that have reached the fruitful criteria or not. the use of formative assessment is very effective in determining the extent to which learners master the teaching material that is presented at each stage of the learning process [5]. The purpose of this research was to determine the form of fruitful criteria formative assessment questions on work and energy concept based on directing motives and syntactical aspects.

Research on the assessment of teaching and learning using the pedagogy subject matter approach has been conducted by [6]. His research shows that pedagogy subject matter is an approach that can be used to assess the learning process of science in the classroom.

2. Methods

The research method used is a qualitative research method with a case study approach. The qualitative method is used because it places more emphasis on holistic descriptions, namely, about describing in detail all that happened at the time of the research rather than comparing certain effects [7]. The case study approach was chosen because this research only focused on interactions between educators, students and teaching materials during the learning process.

Data were analyzed using discourse analysis, this is based on assumptions about teaching and learning activities which are a phenomenon of discourse [8]. The data in this research were in the form of video recordings of learning activities in the classroom and formative assessment sheets used during the learning process with research subjects namely the students of 10th grade high school in Bandung district and the teacher is male with 31 years old.

The research instrument used in the form of indicators of teacher instructor motives, indicators of aspects on the subject matter and indicators of students' knowledge criteria. One of the indicators of teacher instructor motives in the form of educators is able to direct the concepts received by students so they can solve problems; indicators on the subject matter one of which is a decrease in the equation of the law of conservation of mechanical energy; and for fruitful criteria indicators one of them is in the form of students can analyze the law of conservation of mechanical energy.

This indicator is used to see the motives of the educator during teaching, the delivery of aspects of subject matter and the students' knowledge criteria during the learning process. Data analysis was performed by changing the learning video recording results into a text in the form of transcripts, then refinement of the transcripts was done, through deletion and insertion so that it became the basic text, decreased macro and micro propositions, and then made a macro structure [9].

The final step, from the macro structure, is analyzed the appearance of each teaching motive of educators, aspects of subject matter and students' knowledge criteria in formative assessment by summing each appearance of motives, aspects and criteria based on PMS for each category, then calculating the percentage of motives, aspects and aspects of emergence knowledge criteria on formative assessment based on PMS.

3. Result and Discussion

Formative assessment used by educators to find out the development of learners' knowledge in energy learning activities there are five types namely observation sheets, competency tests, quizzes, practicum activity sheets and discussion sheets. After a discourse analysis using the indicator indicators of formative assessments made by educators in learning activities of work and energy, a formative assessment of fruitful criteria is obtained which is interpreted in the Figure 1.

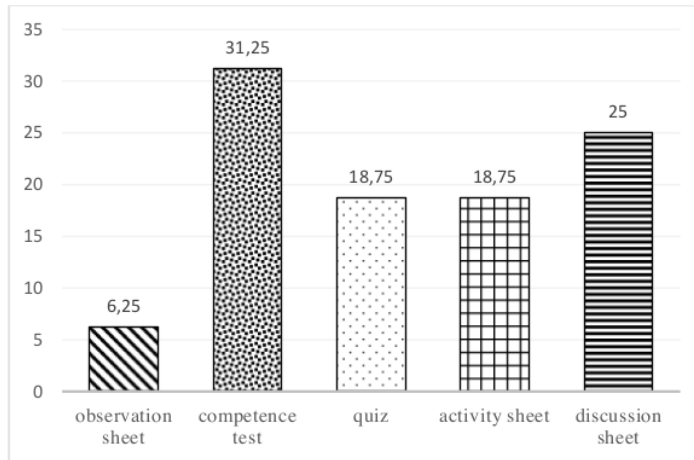


Figure 1. Recapitulation of Fruitful Criteria in Formative Assessment

The most occurrence of fruitful criteria in formative assessment was in competency test with a percentage of 31.25% while in the observation sheet only 6.25% was the smallest appearance of fruitful criteria in formative assessment. The most appearance of fruitful criteria on formative assessment is on the competency test sheet, this is because on the competency test sheet educators present a lot of questions about problem solving, and the smallest appearance of fruitful criteria on formative assessment is on the observation sheet. This can be caused because on this observation sheet educators are more inclined to know the extent to which students' understanding of the demonstration is conducted and its relation to energy is not too focused on problem solving. Herni also said that the observation sheet function in learning is as: a) Teaching material that makes it easy to interact with the material provided; b) Presenting tasks that increase mastery of the material; c) Train learning independence, and d) Facilitate educators in giving assignments [10].

Fruitful is understood as an intellectual skill [11]. According to [12] intellectual skills are scientific process skills that are owned and used by scientists in researching natural phenomena. Anna [13] revealed that science process skills are all scientific skills used to find concepts or principles or theories in order to develop existing concepts or refute previous findings. Science process skills include skills: observing, communicating, classifying, measuring, inferring, predicting, identifying variables, identifying tabulations, identifying graphs, describing variable relationships, obtaining and processing data, analyzing investigations, formulating hypotheses, conducting experiments.

Based on the description above, the fruitful criteria questions contained in the formative assessment given by educators all enter into one of the characteristics of science process skills. This means that all questions that are based on criteria indicators included in the fruitful criteria are indeed true because they also fit into one of the characteristics of science process skills.

Table 1. Recapitulation of Directing Motives, Syntactical Aspects and Fruitful Criteria in Pedagogy Subject Matter Approach.

PSM Category	Number of Appearances
Directing Motives	11
Syntactical Aspect	6
Fruitful Criteria	16

Table 1 shows that formative assessment with fruitful criteria there are 16 questions from all formative assessments used by educators namely observation sheets, competency test sheets, quiz sheets, practicum activities sheets and discussion sheets. Whereas the directing motive that appeared 11

times from two learning meetings and the syntactic aspects of teaching materials contained six materials. From 16 fruitful criteria questions on formative assessment based on the teaching motives of educators by directing (directing) and the syntactic aspects contained in the teaching material there are six questions which is interpreted in the Figure 2.

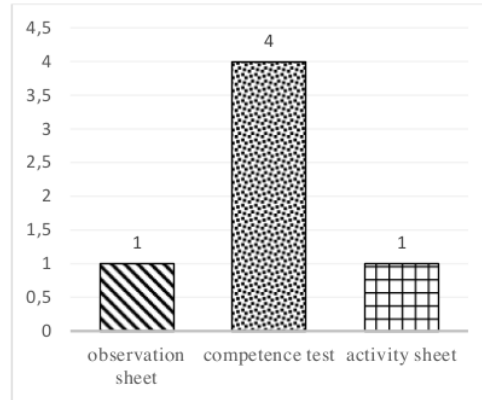


Figure 2. Recapitulation of Fruitful Criteria based on Directing Motive and Syntactic Aspect

Here is a detailed explanation of 6 formative assessments based on directing motives and synthetic aspects presented in Figure 2:

1. Rudi helps Dad to push a broken car. Rudi needs W's effort to move the car from rest to speed v . to accelerate the speed of the car to $2v$ from a standstill, what is the effort required?

The assessment above is in the observation sheet question number five. This question arises based on the directing motives of educators, namely when educator direct students to be able to find similarities in work by referring to the syntactic aspects of teaching materials regarding the reduction of work equations.

2. An object with a mass of 1 kg is thrown vertically up with an initial speed of 20 m / s. acceleration due to gravity 10 m / s². Critically, the height of an object when its potential energy is equal to the maximum kinetic energy is ...
3. When thrown up, a rock will experience a change in potential energy BECAUSE During the upward move, the gravitational force on the rock makes a negative effort

These two questions appear on the competency test sheet number six and number eight. This question arises based on the directing motives of educators, namely when directing students to derive the gravitational potential energy equation from the work equation that refers to the syntactic aspect of teaching material about gravitational potential energy.

4. A work of 75 J is needed to stretch a spring of 5 cm. the work to stretch a 3 cm spring is ...

This question appears on the competency test sheet number four. This question arises based on the directing motives of educators namely when directing students to be able to reduce the spring potential energy equation by referring to the syntactic aspects of teaching material about spring potential energy.

5. An airplane moves with kinetic energy T . If the speed becomes two original speeds, then the kinetic energy becomes ...
6. Analyze the time and speed of objects sliding against their kinetic energy!

This question appears on the competency test sheet number seven and on the practicum activity sheet number six. This question arises based on the directing motives of educators, namely when directing

students to reduce the kinetic energy equation by referring to the syntactic aspects of teaching materials about kinetic energy. This is in accordance with the results of research that has been done [14,15] which states that formative assessment especially those that can measure fruitful criteria need to be done in schools with the aim of seeing students' abilities in solving problems.

Formative assessment has three key components namely evidence of students' knowledge and understanding, the nature of feedback given to students, and changes in the way students learn [16]. Formative assessment can usually be done after the test, but educators also use formative assessment during learning to identify certain students' misconceptions, provide feedback to students to help them correct their mistakes, and identify and apply teaching corrections Vonauf [17]. So that educators can find out the extent to which the students' knowledge criteria and to verify this educator provides a formative assessment in the form of a test.

4. Conclusion

Formative assessment of fruitful criteria based on directing motives and syntactic aspects there are six questions, one from the observation sheet, four questions from the competency test and one question from the practicum activity sheet. Based on the above conclusions, the researcher suggests doing research on other criteria so that it can be known in full the types of questions for formative assessment based on the pedagogy subject matter approach.

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