Development of student performance assessment based on scientific approach for a basic physics practicum in simple harmonic motion materials

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Abstract. This research aims to develop students' performance assessment instrument based on scientific approach is valid and reliable in assessing the performance of students on basic physics lab of Simple Harmonic Motion (SHM). This study uses the ADDIE consisting of stages: Analyze, Design, Development, Implementation, and Evaluation. The student performance assessment developed can be used to measure students' skills in observing, asking, conducting experiments, associating and communicate experimental results that are the '5M' stages in a scientific approach. Each grain of assessment in the instrument is validated by the instrument expert and the evaluation with the result of all points of assessment shall be eligible to be used with a 100% eligibility percentage. The instrument is then tested for the quality of construction, material, and language by panel (lecturer) with the result: 85% or very good instrument construction aspect, material aspect 87.5% or very good, and language aspect 83% or very good. For small group trial obtained instrument reliability level of 0.878 or is in the high category, where r-table is 0.707. For large group trial obtained instrument reliability level of 0.889 or is in the high category, where r-table is 0.320. Instruments declared valid and reliable for 5% significance level. Based on the result of this research, it can be concluded that the student performance appraisal instrument based on the developed scientific approach is declared valid and reliable to be used in assessing student skill in SHM experimental activity.

1. Introduction
As a benchmark to determine the level of success of students in the learning process of a particular competence is by assessment. Ministry of Education and Culture of RI (2016) stated that “Assessment is the process of collecting and processing information to measure student achievement learning outcomes” [1]. Assessment of learning outcomes essentially aims to measure the success of learning conducted by lecturers and simultaneously measure the success of students in the control of the competencies that have been determined. Thus, lecturers can obtain information in knowing the extent to which the achievement of student learning outcomes are shown in the mastery of attitudes, knowledge, and skills of students on the material that has been submitted.

In the current circumstances lecturers have not been maximal in carrying out the assessment. In the teaching and learning process, evaluation aspects of learning outcomes are ignored. Lecturers are too focused on what will be taught to the students. As a result, the teaching and learning process works well and neatly but the assessment tools used no longer see the target to be assessed [2]. The lecturer does not determine the appropriate topic for the student level and the appropriate criteria for the topic, as well
as the lecturer's knowledge in preparing the appraisal instrument is still lacking [3]. In practice on campus, professors often make the instrument without following certain rules [2]. In other hand, assessment of learning outcomes should be done as accurately as possible using the appropriate assessment instruments. Thus a good scoring system is needed to determine the student's learning outcomes, which include the form and instrument of assessment.

Assessment cannot be done only in the cognitive domain only, but overall, assessment becomes part of the construction of students' attitudes, knowledge and skills that are done in a real and comprehensive manner based on student activities [4]. Assessment of student learning outcomes include competence attitudes, knowledge, and skills that are done in a balanced so that it can be used to determine the relative position of each learner to established standards [5]. Therefore, the evaluation system of learning began to grow from the traditional system into a more authentic assessment system (real), and one part of the authentic assessment of assessing the skills (psychomotor) students during the learning process.

One form of authentic assessment that can be used to provide overall information related to the development and achievement of students' Physics learning outcomes is performance appraisal. Performance appraisal is an assessment in the form of a demonstration used to determine a student's skills or skills about something, such as demonstrating movement, and so on [5].

Assessment of performance has emerged as an alternative method to measure what students know and can do real he [6]. Performance appraisal is part of an authentic assessment that are considered able to better quantify the overall results of student learning, because these assessments evaluate the progress of learning not through results but also processes and in various ways. [4] Performance appraisal is one of the highly recommended assessment techniques in physics learning especially for psychomotor domains [7]. Performance appraisal can also be used as an alternative assessment [8]. So this form of performance appraisal can help the development of student knowledge.

A study about the Performance Assessment which conducted by Marmara University in 2008 in the Journal of Turkish Science Education shows that this Performance Assessment provides assistance to students to build and develop their knowledge, where teaching and assessment are two processes that give meaning to each other. Therefore Performance Assessment is considered indispensable as an intermediary that is able to give feedback to students in the learning process. In addition, Performance Assessment is also considered very necessary in assisting lecturers to build student knowledge.

Assessment of existing performance still creates various constraints and shortcomings in the implementation and cannot assist the task of lecturers in carrying out the assessment. One lack of performance appraisal is the subjectivity and inconsistency of the scorers in scoring [9]. Another constraint is the guidance of scoring in the instrument is not clear, the components that are considered difficult to observe, the rater is generally only one person is the lecturer field of study, while the assessed components and the number of students assessed quite a lot, there may be a tendency to Rated high or vice versa [9]. For that the existing performance appraisal needs to be further developed to overcome or minimize the constraints as mentioned above.

2. Methods
The research method used research and development method with consideration in accordance with the objective in this research is to produce product in the form of performance appraisal instrument. The method used is ADDIE (Analyze, Design, Develop, Implementation and Evaluation) which formulated by Reiser and Mollenda. The ADDIE method used is adapted to the assessment instrument development procedure. In general, this research consists of five stages, namely Needs Analysis, Instrument Design, Instrument Development, Implementation, and Evaluation. In general can be described below.

2.1. Stages of Analyze: Needs Analysis
Initial stages in the implementation of this research is the collection of information to find the potential and existing problems. This information gathering was conducted with literature study on the usefulness of using performance appraisal in measuring students' skill competency level.
2.2. Stage Design: Instrument Design
The assessment instruments generated in this study are prepared by first establishing the competencies to be assessed. The basic competence that will be used in this research is Basic Competence which is “Planning and conducting harmonic vibration experiment on swing pendulum and spring vibration” which in this research experiment added with U-pipes. This competency is then adapted to the learning approach used, i.e., by a scientific approach based on ‘observing, asking, trying, associating, and communicating’. Once the competence is in accordance with the scientific approach is determined, then the next stage is to determine the initial form of the instrument to be developed, the form of instruments to be developed is a check list. After the instrument form is established, then the next is to make adjustments of teaching materials in this case is Simple Harmonic Motion (SHM). The material is tailored to the task list to be created into the assessment instrument.

2.3. Stages Develop: Instrument Development
The first step in developing this assessment instrument is to determine or create a blue print in the form of a matrix containing the specification of the instrument to be made, including indicators, statements, item numbers, and assessment scales and assessment rubrics. This assessment rubric is designed to provide a reference to lecturers to provide assessments to students. The more criteria are met then the value of student skills will be higher too. The reference criteria composed consists of 3 criteria in each item, where a maximum value is 3 and a minimum value is 1.

2.4. Stages of Implementation: Trial
After the initial instrument form is developed then the next field test will be carried out early. In this initial field test phase is done with small-scale test. Small-scale trials were conducted with a subject or sample of 3 students. Based on the results of small-scale tests conducted with individual trials, it will get the results from the initial quality of the product. Information obtained from this initial field test is then will be analyzed for revision of the instrument. This revision aims to improve the initial instruments tested on a small scale. Improvements made to components in the assessment instrument are not yet valid.

The large-scale test was conducted by field testing, the field trial was conducted on larger large groups, with the subject or sample of 36 students. The selected classes should be classes that represent the characteristics of students within the campus. After conducting field trials it will get the data then used to obtain the level of validity and reliability of the developed instrument. This revision is made to further ensure that the instruments used are valid and reliable in accordance with the guidelines made by Dikti-Kemenristek, Republic of Indonesia. After the final revision is done then the products in the form of student performance appraisal instruments can already be used en masse. The final product that has been done several times of trial and obtained the value of validity and reliability is high then the final stage is done dissemination through Physics national seminar.

2.5. Evaluate Stages: Evaluate
Basically this evaluation can be done at any stage, or so-called formative evaluation, because this evaluation we use for revision needs.

3. Results and Discussion

3.1. Results of Need Analysis
The result of the first observation of 10 lecturers in the learning activity of Simple Harmonic Motion (SHM) material at several universities in Jabodetabek found that 10% have used performance appraisal instrument, 70% of lecturers did not use any instrument in performance evaluation, and 20% Student performance on experimental activities by assessing the student's final report. As well as on the difficulties of performance appraisal, 60% of lecturers find it difficult to conduct student performance assessments.
In addition for not performing performance appraisals in the experimental activities, teachers also do not have specific criteria for assessing the students' skills in conducting shm experiments, the criterias are general criterias and do not describe the characteristics of shm experiments. So, it is needed development of student performance assessment based on scientific approach for a basic physics practicum in simple harmonic motion materials.

3.2. Validation Results

Validation results by peers who are experts in assessment instruments in the form of inputs, corrections, and suggestions on assessment instruments as shown in Table 1.

Table 1. Assessment results of research-based performance appraisal instruments.

| Number | Assessment | Input |
|--------|------------|-------|
| 1      | Expert 1   | It is necessary to include advice for lecturers technically related to assessment / assessment by lecturers if at the same time practicum in groups of students do the same, so that teachers cannot monitor all the students do at the same time |
| 2      | Expert 2   | When the simultaneous assessment by the lecturer cannot be performed, it is necessary to make an assessment of what can be done simultaneously in the experiment |
| 3      | Expert 3   | For the third experiment on fluid oscillations on the U-tube it seems quite difficult, but if you want to try it please just be less appropriate. However, the overall contents of the task on the instrument have been good, the assessment can be done carefully where there was helping. |
| 4      | Expert 4   | Components of tasks on the instrument is good, it is in accordance with the psychomotor development of students. For input, before conducting the assessment, it is necessary to discuss with other lecturers related to technical implementation, so that the assessment becomes maximal and all the lecturers understand the technical assessment |

Validation results by peers who are experts in assessment instruments in the form of inputs, corrections, and suggestions on assessment instruments as shown in Table 1.

Table 2. Assessment results of research-based performance appraisal instruments.

| Number | Aspects of the Measure | Maximum Value | Rating Result | Percentage | Information |
|--------|------------------------|---------------|---------------|------------|-------------|
| 1      | Construction of Instruments | 120           | 100           | 85 %       | Very Good   |
| 2      | Material               | 40            | 35            | 87.5 %     | Very Good   |
| 3      | Language               | 40            | 34            | 83.3 %     | Very Good   |
|        | **Average**            |               |               | **85.27%** | **Very Good** |
3.3. Validation Result Test of the Trial Result

After the instrument is tested to students of Undergraduate Faculty of Science I with 40 students, further analysis will be done to test validity (validity) and calculate reliability (reliability) using SPSS 12 program. From the 40 grains assessed to students, a small group of 33 valid grain points and 7 invalid rating points. Grain assessment of small group results to 6 students, declared valid with the degree of reliability of the instrument 0.878 where r table is 0.707. Because the R-count value is greater than R-table, it is declared reliable.

Then, of the 33 items were tested in large groups and obtained 33 items were valid and no item was declared invalid. The grain of assessment of the results of the group's group to 36 students is declared valid with the degree of reliability of the instrument 0.889 where r table is 0.32. Because the R-count value is greater than R-table, it is declared reliable. The calculation results of construct validity of each point of assessment from the test to the student can be seen in Table 3 below.

**Table 3. Test result data of construct validity of any grain assessment on large scale trial.**

| Item Number | r-count | r-table | Information | Item Number | r-count | r-table | Information |
|-------------|---------|---------|-------------|-------------|---------|---------|-------------|
| 1           | 0.722   | 0.329   | Valid       | 18          | 0.722   | 0.329   | Valid       |
| 2           | 0.627   | 0.329   | Valid       | 19          | 0.469   | 0.329   | Valid       |
| 3           | 0.481   | 0.329   | Valid       | 20          | 0.493   | 0.329   | Valid       |
| 4           | 0.416   | 0.329   | Valid       | 21          | 0.469   | 0.329   | Valid       |
| 5           | 0.644   | 0.329   | Valid       | 22          | 0.527   | 0.329   | Valid       |
| 6           | 0.493   | 0.329   | Valid       | 23          | 0.722   | 0.329   | Valid       |
| 7           | 0.527   | 0.329   | Valid       | 24          | 0.469   | 0.329   | Valid       |
| 8           | 0.436   | 0.329   | Valid       | 25          | 0.469   | 0.329   | Valid       |
| 9           | 0.513   | 0.329   | Valid       | 26          | 0.595   | 0.329   | Valid       |
| 10          | 0.433   | 0.329   | Valid       | 27          | 0.532   | 0.329   | Valid       |
| 11          | 0.595   | 0.329   | Valid       | 28          | 0.532   | 0.329   | Valid       |
| 12          | 0.532   | 0.329   | Valid       | 29          | 0.333   | 0.329   | Valid       |
| 13          | 0.722   | 0.329   | Valid       | 30          | 0.452   | 0.329   | Valid       |
| 14          | 0.380   | 0.329   | Valid       | 31          | 0.359   | 0.329   | Valid       |
| 15          | 0.375   | 0.329   | Valid       | 32          | 0.382   | 0.329   | Valid       |
| 16          | 0.664   | 0.329   | Valid       | 33          | 0.532   | 0.329   | Valid       |
| 17          | 0.417   | 0.329   | Valid       |             |         |         |             |
3.4. Validation Result Test of the Trial Result

After going through several revisions and evaluations, it was obtained the grading by scientific approach as in table 4.

| Item Number | Assessment Item |
|-------------|-----------------|
| 1           | Observe the pendulum oscillation with the eye position perpendicular to the pendulum equilibrium point |
| 2           | Observe the thickness of the rope that is used if there is a twist when the pendulum oscillates. |
| 3           | Observe the strings of the rope so as not to exceed the 10° angle. |
| 4           | Observe the oscillation of the spring with the eye position perpendicular to the load balance point on the spring. |
| 5           | Watching the spring state is still functioning properly or not |
| 6           | Observe the oscillation of fluid in the U-tube with the eye position perpendicular to the point of fluid balance. |
| 7           | Observe the deviation given so that the liquid in the U-tube is not spilled. |
| 8           | Asking questions related to what / when / where the experiment should be done properly and correctly |
| 9           | Ask questions related to step work in experimental procedures. |
| 10          | Ask questions related to how the experiment is done properly and correctly. |
| 11          | Assembling tools and materials used in accordance with experimental procedures. |
| 12          | Putting the tools and materials used safely and not endangering other students. |
| 13          | Determine the balance point of the pendulum oscillation before starting the experiment. |
| 14          | Calculates the period of pendulum oscillation when the pendulum has moved in harmony. |
| 15          | Start and stop timing when the pendulum is right in its balance position. |
| 16          | Determine the spring oscillation balance point before starting the experiment. |
| 17          | Calculates the spring oscillation period when the spring is moving in harmony. |
| 18          | Start and stop timing when the load on the spring is in its equilibrium position. |
| 19          | Determine the balance point between the two sides of the U-tube before tilting the U-tube. |
| 20          | Start and stop timing when the fluid is in its equilibrium position. |
| 21          | Identify the value of the pendulum oscillation period obtained proportional to the length of the rope. |
| 22          | Identifying the value of the pendulum oscillation period obtained is not affected by the pendulum mass. |
| 23          | Identify the value of the spring oscillation period obtained proportional to the load mass used. |
| 24          | Identifying the value of the spring oscillation period obtained is inversely proportional to the spring constant value. |
| 25          | Identify the value of the period of fluid oscillations in the U-tube obtained proportional to the length of the liquid column. |
| 26          | Identifying the value of the period of fluid oscillations in the U-tube obtained is not influenced by the density of the liquid type. |
| 27          | Presents experiment data in table form. |
| 28          | Presents experiment data in graphic form. |
| 29          | Make conclusions based on the graph made. |
| 30          | Using good and correct Indonesian in preparing reports. |
| 31          | Compile reports systematically, logically, and rationally. |
| 32          | Deliver experimental results in easy-to-understand language. |
| 33          | Responding to questions logically and rationally. |
4. Conclusion
Based on the results of research and discussion, it can be concluded that has been developed instrument of student performance appraisal based on scientific approach in the form of assessment sheet in the form of list of tasks that can be used to obtain information on the result of study of physics of high school students appropriately. Student performance appraisal instrument developed has 100% grain rating eligibility level with content validation level based on instrument construction 83.3%, material 87.5%, and language 85% with excellent interpretation. In terms of construct validity, the student performance appraisal instrument developed has 33 valid grain points with instrument reliability levels at a significance level of 5% of 0.889 or in very high categories.

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