Implementation of Performance Assessment in STEM (Science, Technology, Engineering, Mathematics) Education to Detect Science Process Skill

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Abstract. A descriptive study about the implementation of performance assessment in STEM based instruction was carried out to investigate the tenth grade of Vocational school students’ science process skills during the teaching learning processes. A number of tenth grade agriculture students was involved as research subjects selected through cluster random sampling technique (n=35). Performance assessment was planned on skills during the teaching learning process through observation and on product resulted from their engineering practice design. The procedure conducted in this study included thinking phase (identifying problem and sharing idea), designing phase, construction phase, and evaluation phase. Data was collected through the use of science process skills (SPS) test, observation sheet on student activity, as well as tasks and rubrics for performance assessment during the instruction. Research findings show that the implementation of performance assessment in STEM education in planting media could detect students science process skills better from the observation individually compared through SPS test. It was also found that the result of performance assessment was diverse when it was correlated to each indicator of SPS (strong and positive; weak and positive).

1. Introduction
Education is very important aspect in human life. One of main efforts to improve the quality of education in Indonesia is curriculum development. Currently the development is applied by changing KTSP curriculum into the curriculum of 2013. Permendikbud No. 65 of 2013 states that the assessment of the curriculum 2013 uses authentic assessment that assess students’ readiness, learning process, and their achievement entirely.

The demands of curriculum 2013 assessment, which not only assess aspect of knowledge, but also aspect of the psychomotor and attitude, as well as a through assessment during the learning process, it is necessary to apply that emphasizes the assessment process. One sort of assessment for learning that may be applied in the curriculum 2013 is the performance assessment.

Experts and some education researchers [11; 9; 13] stated that the assessment of the performance assessment is authentic assessment to assess the student's ability to apply the concepts to real situations, assess the ability of scientific work in learning science, can train students in having a positive mental attitude, and skillfully solve any problems. This assessment not only be used to assess learning outcomes or products, but also can be used as part of learning [5].

The use of performance assessment can not be separated from the learning process. One suitable learning approach using performance assessment is the study of STEM (Science Technology
Engineering Mathematics). With the performance assessment in STEM education, we can assess every phase in STEM approach. There are indicators to assess those phase in performance assessment that implemented in this research. Futhermore, this performance assessment completed with indicators that can assess science process skills. With indicators that held in performance assessment, allows the teacher to conduct an assessment during the learning process.

In STEM education, after the students finish making the project, it will be tested whether it is as expected or not. If not, then it will be redesigns. This process is implemented because STEM based instruction emphasizes mostly on engineering stage, but still intersects with the scientific processes [10].

In this study, the assessment of performance is implemented in the preparation of planting media. This subject is a contextual concept in daily life. There is a problem or issue that can be made from this material to be solved through STEM based instruction, such as the reduction of planting area in urban zone. The study was conducted in a vocational high school which enable implementing STEM based instruction. This is because the vocational education has a purpose as stated in Government Law No. 20 of 2003, which is to produce learners who are experts in their chosen fields to compete professionally, both in terms of knowledge and technology [6].

2. Method
The method used in this research is descriptive method. This study aimed to uncover the science process skills early on during the process of implementation of performance assessment on the subjects of preparation of the planting medium.

This research was conducted at only one class, without the control class. In determining the working group. Implementation assessment starts from the beginning until the end of the lesson. Assessment includes the discussion process, the implementation of the trial, during the observation (21 days to see effectivity of planting media that have been made previously), reporting and presentation. The results obtained in each activity are analyzed, to be concluded.

Participants in this research were 35 students from vocational high school 3 Baleendah, Bandung regency, with competence and expertise of Agribusiness and Tissue Culture Technique. Subject of this research were 10th grade students. Sample was taken using random cluster sampling technique.

Data obtained is qualitatively and quantitatively analyzed. In addition, the performed data analysis using SPSS Statistics 23 to show regression and Pearson correlation test on the variables of data, consisted of task 1, task 2, task 3 results and all the SPS indicators.

3. Instrumentation
The instruments used in this study include observation sheets, task rubric of performance assessment, and test on science process skills. Observation sheets used during the learning process, especially on the phase of constructing. Observation sheet was used directly during students performance. While the task and the rubric is used to analyze the science process skills indicators contained in the report, whereas the science process skills test was administered to students at the end of the lesson. The test result was then compared to the results of observations made previously.

The performance assessment given consists of three tasks. The first task was the elaboration of constructing and designing phases. Indicators of science process skills assessed on the first task is asking investigable questions, testing hypothesize, and designing experiments. The second task is the implementation of the stage for covering the manufacture of products in accordance with the design that was planned earlier. Indicators of science process skills (SPS) that were assessed at this stage were observing, classifying, using the tools and materials as well as conducting experiments. The third task was the implementation of the test phase. SPS indicators assessed at the third task included communicating, interpreting, predicting, and applying concept.

While SPS indicators that can be determined through tests including interpretation, predicting, communicating, asking questions, applying the concept, planning experiments, classification, and hypothesize. The tests were given consisted of 20 questions that represent indicators of SPS has been
described previously, with five possible answers. Each correct answer was given a score of 1 while another false one was given a score of 0.

4. Results

The data resulted from this study was obtained in two ways: by direct observation (i.e. for indicators of observing, classifying, using apparatus and equipment, and doing experiments); and through reports made by each student (i.e. for indicators of questioning, hypothesizing, interpretation, predicting, communicating and applying the concept). To ensure, the result data was also supported by SPS test result. The whole profile of science process skills of students as in Figure 1.

According to the data obtained, it can be seen that the achievement of students in answering SPS questions is still low, as seen in Figure 1, while in practical study, the student ability of SPS is good. On observation results, the lowest SPS indicator of the ability of students is predicting (53%) while the highest is asking questions (89%).

![Figure 1. Profile of Students Science Process Skills](image)

In contrast with the results obtained by students in answering questions, the ability of students who are lowest on SPS indicators of applying concept (25%), while the highest for the interpretation SPS indicators (64%). In the matter given to the student, not given the matter for observing indicators, using apparatus and equipment, as well as doing experiments, because these three indicators can only be expressed directly.

Contributions assessment of performance in revealing the ability of SPS students can be seen in Figure 2. In the first task, through group discussions, performance assessment can uncover some indicators SPS owned by the students, such as questioning, hypothesizing, and designing experiments. Measurement of indicators seen asking questions of formulation of the problem created by the students, while designing experiments judging by the way the students identify the variables, determine the tools and materials, and determine the procedure. The first task assessment is based on students' worksheets.

![Figure 2. Contributions Assessment of Performance in SPS Revealing](image)
by how students distinguish planting media group organic and inorganic. The second task assessment based on the observations made by researchers.

In the third task, which revealed SPS include communicating, interpretation, applying the concept, and predicting. Measurement communicating by looking at how the students in presenting the observed data. Indicator interpretation is measured by looking at how students make conclusions, applying the concept measured by the analysis of data and predicting measured by observing at how students provide design ideas improvement based on experiments that have been done before.

The correlation that exists between performance assessment with science process skills are shown in Table 1. The data shows that the assessment of the performance have a strong relationship and significant impact on the results of science process skills in observation, but has a weak relationship to the test results.

| Performance Assessment | SPS (observation) | SPS (Text) |
|------------------------|-------------------|------------|
| Pearson Correlation    | 1                 | .860**     | .283       |
| Sig-(2-tailed)         |                   | 0.000      | 1.000      |
| N                      | 35                | 35         | 35         |

5. Discussion
The Based on data obtained stating that the performance was good at observation results are shown in Figure 1 supposedly because during the learning process there is feedback from teacher to students, as stated by Earl [4] that assessment for learning can help students understand the subject. Besides the learning experience directly in accordance with the nature of science that not only trains students in knowledge but also skills and attitudes [3].

The achievement of science process skills of students is still low, especially in questioning due to lack of familiarity SPS students in answering questions like that. Students in Indonesia are generally more accustomed to answer the questions that are more knowledge given [7]. This is supported by the TIMSS results show that Indonesian students excel when working on theoretical problems and memorization. But collapsed when faced with questions that reveal aspects of high level. This fact shows that the students have not been able to use the concepts he learned and use logic thinking (reasoning) in resolving the matter. Additionally these results show that learners Indonesia is still lacking in conceptual understanding.

As the students are not used to the process of scientific method in practical activities, it will result in evidence the low achievement of students SPS test. Low achievement is also evident from the results of TIMSS and PISA, where Indonesia was ranked 40 out of 42 countries took part in TIMSS in 2011 and was ranked 64th out of 65 countries took part in PISA in 2012 [2].

The implementation of performance assessment given to students can express science process skills of the students. This is because in a given performance assessment as SPS indicators can be viewed directly or can be analyzed through reports and daily student journals. Unlike the SPS tests given at the end of the lesson, less able to uncover the science process skills of students because students are not used to work on the SPS problems. Moreover, most likely students guess the answers to the SPS tests for a given problem in the form of multiple choice, and also weaknesses in the given problem, there is still a matter of concept load, whereas good SPS is a matter which does not include the concept.

The amount of the acquisition value lower on tests of SPS with indicators predicting, hypothesizing, communicating, designing experiments (particularly in the identification of variables), as well as asking questions supposedly due in achieving the indicators necessary thinking skills, it is also reinforced by still many students who were at the level of concrete thought. In theory, the students
age of tenth grade (15-16 years) is already at the level of thinking formally, but the level of intellectual development not only determined just by age, but is also influenced by the maturity, the experience of physical, logical-mathematical experience, social transmission and process the balance or the regulatory process itself [8; 1].

Based on Figure 2, the indicator is still low of SPS achievements are in task 1 and task 3. In the first task, the indicator is still low are hypothesized. In hypothesize, students must first understand how to specify the variables involved in the experiment, which is then connected between the two variables that had been predetermined. The hypothesis is also an approximate cause of the matter [9]. It takes skill to think in formulating hypotheses. It is also associated with cross-cutting concept of cause and effect arising from planting media used to plant growth and physical and chemical properties of growing media.

As for the third task, which is still low are predicting and apply concepts. Both of these indicators are very skilled thinking. This is because the indicator predicted, students tried to propose the type of planting media or the other based on the pattern that has happened before. In applying the concept, students should be able to link the results obtained with the preparation of the concept of growing media, plant growth, and hydroponics.

The thing that is contributing to the low achievement of students in terms of SPS and SPS indicators that require intellectual or thinking skills, the study habits of students who put more emphasis on manipulative skills (hands on) without taking part in developing the intellectual or thinking skills of students (minds on). This finding is consistent with the study conducted by Sumartini [12], that the vocational students by learning with a problem based learning has good reasoning power than vocational students who undergo conventional learning (hands-on only).

Based on the data obtained, it is known also that performance assessment conducted in this study can work well in every phase of STEM. This can be seen through the SPS indicator of students that can be detected in every phase. In addition, it can be seen also through the correlation between the performance assessment with SPS observation that shows a positive value.

Strong correlation relationship with the observation of science process skills for activities supposely undertaken students aiming to develop science process skills. This is because in learning activities, students are trained to perform lab activities are in line with the scientific method. This activity helps students understand the material preparation of the growing medium, because in the practical work, students become more active and students also have direct experience, so that the material presented will be long remembered by the students. This is consistent with the theory of the Edgar Dale’s Cone of experience.

6. Conclusion
Based on the data obtained, it can be concluded that the assessment of the performance characteristics used are divided into two, namely votes directly and indirectly. Comparison of the results of tests and observation is that the observation of the student better able to describe the actual ability. Now, every task given to the students in this study were able to uncover the representative of indicators science process skills, and based on the correlation analysis, assessment of performance has a strong correlation to the results of science process skills in observation, and a weak relationship to the test results.

7. References
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