The role of performance and self-assessment to determine students’ science process skills in SMP Negeri 11 Kota Tangerang Selatan

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Abstract. This study aims to describe the pattern of students' scientific processes based on observations when performance appraisals are carried out. Science process skills are assessed using performance indicator instruments and supported by student self-assessment instruments. The research method used in this research is descriptive analysis. Data collection instruments in this study were observation sheets, student worksheets, and self-assessment sheets. Research subjects were 38 students of grade seventh in SMP Negeri 11 Kota Tangerang Selatan. The results of the study showed from 3 out of 10 aspects of observed skills that still score below 80%. These aspects were aspects of asking (75%), apply the concept (77.7%), and communicate the results (65.5%). However, three aspects have been in the good category. The aspects of science process skills with 100% value owned by students are aspects of prediction and hypothesis formulation. There are two aspects of science process skills that have opposite results from the results of students' self-assessment, namely aspects of developing hypotheses and communicating. Hypothesis aspect in self-assessment has a value of 79%, this is contrary to the results of observations using performance appraisal. In addition, the aspect of communication in self-assessment also has the opposite results from observations in a performance evaluation that is equal to 89%. Even so the category of science process skills possessed by students in the assessment of performance indicators and self-assessment included in both criteria.

1. Introduction
The education in the 21st century aims to create individuals who are students to master the competence due to interaction with others and make a solid teamwork. These competencies can be realized by tapping into the skills needed in this century. These skills are varied including: a) the ability to solve problems, b) communication and collaboration skills, c) the ability to be active, innovative, and equip themselves with science, and d) the ability to think creatively and analytically [1]. These skills can generally be part of science process skills (SPS). Science process skills are activities carried out by students obtaining knowledge and skills obtained from the results of scientific investigations [2]. On the other hand, according to Susilawati, Susilawati and Sridana, science process
skills are an ability of students to apply scientific methods in understanding, developing, and discovering science when students are escalating their knowledge [3].

The significance of mastering the science process skills in 21st century education for students is to build and solve problems, think critically and also make decisions in finding answers based on curiosity [4]. Science process skills that must be done by students are divided into two categories, namely basic science process skills and integrated science process skills. Basic science process skills are skills that are often encountered every day such as conducting observation, inference, prediction, measuring, conducting experiments, and classification [5]. Whereas, integrated science process skills are the result of the development of basic process skills which consist of compiling hypotheses, generalizing, recording and interpreting data, identifying and controlling variables, and making decisions [6]. There are 10 skills that students in grade seventh need to master from both types of skills, including; observation, classification, prediction, asking, formulating hypotheses, planning experiments, using tools and materials, interpreting, applying concepts, and communicating [7].

Students' science process skills need to be assessed properly. One of assessment instrument that can be used to measure science process skills is the performance instrument. Performance evaluation is done by observing the activities of students. Science process skills are very suitable to be measured by performance appraisal instruments because these instruments can determine the ability of students directly. Performance appraisals provide a broad range of assessments of the knowledge, skills and abilities of the observed objects [8]. This is in line with the results of research by Chabalengula, Mumba, Hunter, and Wilson which shows that science process skills in students can be assessed using performance instruments [9].

Another assessment instrument that is able to measure students' scientific process skills is the self-assessment instrument. Self-assessment is expected to be used by students to find out their shortcomings in learning activities because students are directly involved in assessing themselves. According to Boud, Lawson, and Thompson assessing one's own performance can provide confidence in learning experienced by students [10]. Self-assessment can be used to measure knowledge competencies, attitudes and skills. Student self-assessment is based on the criteria that have been prepared. The use of self-assessment can have a positive impact on students' personality development such as growing self-confidence, being aware of their own strengths and weaknesses and can encourage, accustom and train students to be honest.

One of the methods taught in secondary school (SMP) to measure science process skills is the material regarding the classification of materials and their changes. What is requested in the 2013 curriculum regarding the material is stated in BC 3.3. which states "Explaining the concept of mixtures and single substances (elements and compounds), physical and chemical properties, physical and chemical changes in everyday life". The results of National Exam (UN) absorption in 2018 show that this material has the lowest absorption capacity from other materials, both City / Regency (45.60), Province (38.16) and National (42.73). The indicators of the measurement material, substances and their properties related to the classification of matter and their changes are distinguishing physical / chemical changes from the event of changes in substances, determining the correct separation of mixtures and determining the acidic, basic, or saline solution from the table of changes in acid-base indicators. The absorption of the three indicators on a national scale scores 32.75; 40.54; and 33.74. At the provincial scale the values obtained by the three indicators are smaller than the national scale, which is 27.81; 39.40; and 28.96. In contrast to the national and provincial scale, in the southern Tangerang city scale the value obtained is higher at 33.44; 50.55; and 42.10. However, the value obtained is still far from expected. Based on the problems that have been presented before, this study
specifically aims to describe the measured student SPS using performance instruments and self-assessment.

2. Method
Descriptive research method was used in this research. Descriptive method was chosen because it can describe or reveal the situation as the research conducted. This study describes an analysis of the use of performance appraisal instruments and self-assessment to measure science process skills in science learning. Analysis of the validity of the instruments in this study used the Aiken V formula with an assessor of eight people. eight evaluators with a scale value of four gave a p-value of 0.75. Following is the equation from the Aiken V formula used:

\[ V = \frac{\sum s}{n(c - 1)} \]  \hspace{1cm} (1)

Information:
V: Aiken's validation value V
S: the result of reducing the value of the rater (r) with the lowest validity rating (Lo)
Lo: lowest validity score
C: highest validity rating
N: number of rater (assessor)

The reliability of performance appraisal instruments uses a percentage agreement from Emmer & Millett [11]. The following is a percentage of the agreement used:

\[
Percentage\,agreement = \left[1 - \frac{A-B}{A+B}\right] \times 100\%
\]  \hspace{1cm} (2)

The object of this study consisted of 38 students of grade seventh in the SMP Negeri 11 Tangerang Selatan. This study uses observation sheets for performance assessment instruments and checklist sheets for self-assessment. The data analysis techniques used in the performance evaluation on the observation sheet and checklist data for self-assessment. Data analysis related to observation sheets uses calculations according to the rating scale in accordance with predetermined criteria. The data generated from the observation sheet is tabulated and the percentage is sought. The equation used to find the percentage is:

\[
Percentage\, of \, KPS = \frac{\text{Score}}{\text{TotalScore}(\text{Maximum}\times\text{Samples})} \times 100\%
\]  \hspace{1cm} (3)

In addition, data analysis technique on the checklist for self-assessment also uses a rating scale with the category "strongly agree = 4"; "Agree = 3"; "Disagree = 2"; and "strongly disagree = 1". Data generated on the checklist sheet will be tabulated on each statement and presented. The percentages obtained will be averaged over every aspect of science process skills according to the number of statements contained on the checklist sheet. The equation used to find the percentage is:

\[
Percentage\, of \, Item = \frac{\text{ScoreperItem}}{\text{TotalScore}(\text{Maximum}\times\text{Samples})} \times 100\%
\]  \hspace{1cm} (4)

The average score of students’ science process skills on each students can also be determined based on each indicators so the mean score were taken using instrument sheet. The equation used to find the average of each aspect of science process skills is:
3. Results and Discussion
The results of this study are in the form of performance evaluation observation sheets to measure students' science process skills and checklist sheets used in self-assessment. The results of the performance appraisal can be seen in Figure 1.

![Figure 1. Science process skills aspect on performance assessment](image)

Figure 1 shows that there are three aspects of science process skills that have a percentage below 80%, namely aspects asking questions, applying concepts and communicating. This assessment is carried out during practicum activities on the subject of material classification and changes with basic competencies "Explaining the concept of mixtures and single substances (elements and compounds), physical and chemical properties, physical and chemical changes in daily life", with indicators used is "Explaining the differences in elements, compounds, and mixtures." Practical activities related to basic competencies and indicators are experiments on concepts about acids, bases, and natural indicators.

Asking is aspect number 4 where students are asked to make a problem statement regarding the experiment to be conducted. Asking can mean asking for an explanation, about what, why, how or ask the background of the hypothesis [12]. The results obtained in this aspect amounted to 75% which are categorized as good. In the aspect of asking, students find it difficult to ask questions directly or written in the worksheet of students and only one question posed is related to the experiment so they are not performing any questions due to the concepts taught. Expectations from this aspect learners are able to ask questions at least two questions related to the experiment. This result is in line with the research of Bahriah, Suryaningsih and Yuniati which states that during the learning activities take place the skills of asking questions do not appear, this is because students have not been trained in asking questions especially to ask questions that are based on hypotheses [13].

Applying the concepts is aspect number 9 where students are expected to be able to relate the knowledge they have gained in their daily lives. The application of the concept can be used to explain
something that happens based on knowledge that has been obtained previously [14]. In this activity students are given problems related to acidic and basic compounds, namely those with ulcer disease. The results obtained indicate that students are able to explain the reasons for heartburn sufferers to consume drugs that are alkaline, but still do not know the impact of patients if they consume foods that are acidic. The aspects of applying this concept gained a score of 78% in the good category. In research conducted by Amalia applying the concept by students will be better when there is a process that is carried out repeatedly so that it is able to develop the skills directed at it [15].

Communicating is aspect number 10 where students are asked to submit conclusions that have been obtained from the experiment. The value obtained in this aspect is 66% with a good category. In this aspect students are still unable to provide appropriate conclusions based on experiments that have been conducted. Students often explain the results of experimental data back to this activity so that the expected conclusions are not conveyed properly when they were learning. Communication skills are expected to provide advantages in issuing opinions or explaining a problem obtained from observations and linking it with theories already taught so as to make students better understand the concepts in the material. This is in line with the statements of Rauf, Rasul, Mansor, Othman & Lyndon which states there are five actions that represent communication skills. Among the existing communication skills, actions that students need to master include being able to talk, listen and explain their ideas to the audience. It is found mostly when students are discussing, or when questions arise when doing assignments or experiments and when presenting their assignments.[16].

Figure 1 also shows that there are two very high aspects, namely prediction and compiling hypotheses. In aspect prediction students are asked to identify compounds that are acidic or basic in another way. In this aspect, students are revealed to identify compounds that are acidic and basic using red and blue litmus paper indicators. Prediction skills are based on observing future events based on past observations or data extensions [17]. This makes this aspect higher than other aspects which is equal to 100% which means it is included in the excellent category. These results are also consistent with Ramayanti’s research which shows predictive skills need to be trained to get good categories [18].

Creating hypotheses is aspect number 5 where students are expected to be able to make a provisional guess from the formulation of the problem that has been made in the aspect of asking questions. Hypothesis is the ability to predict with an estimate or estimate based on a variable that will affect other variables so that it becomes the cause of something that has a basis to explain a certain phenomenon [19]. In this aspect, students are able to make guesses that are in accordance with the formulation of the problem made and in accordance with the acid base identification experiment activities that will be carried out. The suitability of the hypothesis given by the experiments to be carried out gives this aspect a value of 100%. So the evaluation criteria on this aspect are very good.
Figure 2. Science process skills from self-assessment checklist

Figure 2 shows the overview of the self-assessment conducted by students. In this assessment, students are given checklist sheets with statements related to aspects of science process skills. This self-assessment is expected to help students know aspects of science process skills experienced in learning activities. There is one of the ten aspects of science process skills that have a value below 80%, namely in aspect formulating hypotheses. This is contrary to the results shown in the performance appraisal which states compiling a hypothesis of 100%. This can be said that the confidence felt by students is still less than the skills performed by students.

Another aspect that has the opposite value between self-assessment and performance evaluation is the aspect of prediction and communicating. In the aspect of prediction, self-assessment experienced by students by 81% compared with the performance evaluation conducted by students that is equal to 100%. Similar to the aspects of constructing hypotheses, the prediction aspect shows that the lack of confidence experienced by students rather than the skills performed in experimental activities. In the communicating aspect, the self-assessment experienced by students is higher than that carried out in the performance appraisal. This shows the high self-confidence experienced by students with a value of 89% compared to the skills possessed by students. This is in line with Nahadi, Firman and Khilda's research which states that there are differences between self-assessment and other assessments. The self-assessment done is lower than the performance evaluation conducted by peers. This is due to a lack of confidence in the results of performance [20]. In contrast to El-Kaomy which states that self-assessment conducted by the subject tends to give higher results to him [21].

4. Conclusion

This research concluded that the observation sheet on the performance appraisal can measure the science process skills of students on the subject matter of material classification and changes. Three out of ten aspects of the measured science process skills have a value below 80% and are included in the good category, while seven out of ten aspects of the measured science process pregnancy have a score above 80% with a very good category. Self-assessment carried out provides an overview of the confidence of students in conducting science process skills activities. One of the nine aspects of science process skills has a value below 80% with a positive category and the rest has a value above
80% with a very positive category. Overall, the science process skills possessed by students of SMP Negeri 11 Kota Tangerang Selatan are already very good.

References

[1] Trilling B, and Fadel C, 2009 21st Century Skills: Learning for Life in Our Times (San Francisco: Jossey-Bass)
[2] Abungu, H.E., Okere, M.I.O., & Wachanga, S.W. (2014). The Effect of Science Process Skills Teaching Approach on Secondary School Students’ Achievement in Chemistry in Nyando District, Kenya. Journal of Educational and Social Research, 4 359-372.
[3] Susilawati, Susilawati, & Sridana, N. (2015). Pengaruh Model Pembelajaran Inkuiri Terbimbing Terhadap Keterampilan Proses Sains Siswa. Jurnal Tadris IPA Biologi FITK IAIN Mataram 8(1) 27–36.
[4] Karamustafaoğlu S 2011. Improving the Science Process Skills Ability of Science Student Teachers Using I Diagrams. Eurasian Journal of Physics and Chemistry Education 3(1) 26-38.
[5] Delen I, and Kesercioğlu T 2012 . How Middle School Students’ Science Process Skills Affected by Turkey’s National Curriculum Change? Journal of Turkish Science Education 9(4) 3-9
[6] Sandall B R dan Singh A 2011 Using STEM to Investigated Issues in Food Production (United State of America: Mark Twain Media, Inc.)
[7] Zulfiani, Feronika T, and Suartini K 2009 Strategi Pembelajaran Sains (Ciputat: UIN Jakarta)
[8] Bastian K C, Henry G T, Pan Y, and Lys D 2016 Teacher candidate performance assessments: Local scoring and implications for teacher preparation program improvement. Journal Teaching and Teacher Education 59 1-12.
[9] Chabalengula V M, Mumba F, Hunter W F J, and Erin Wilson 2009 A Model for Assessing Students’ Science Process Skills during Science Lab Work. Problems of Education in the 21st Century 11 28-36.
[10] Boud D, Lawson R, and Thompson D G 2015 The Calibration of Student Judgement through Self-Assessment: Disruptive Effects of Assessment Patterns. Journal Higher Education Research & Development 34(1) 45-59.
[11] Borich, Gray D. 1994. Observation Skill for Effective Teaching. New York:Macmillan Publishing Company.
[12] Nuryani R 2005 Streategi Belajar Mengajar Biologi (Malang: UM Press)
[13] Bahriah E S, Suryaningsih S dan Yuniati D 2017 Pembelajaran Berbasis Proyek pada Konsep Koloid untuk Pengembangan Keterampilan Proses Sains Siswa. Jurnal Tadris Kimiya 2(2) 145-152
[14] Zeidan A H and Jayosi M R 2015 Science Process Skills and Attitudes toward Science among Palestinian Secondary School Students. World Journal of Education 5(1) 13-24
[15] Amelia A, Hartono & Sari D K 2014 Penerapan Model Problem Based Instruction (PBI) untuk Meningkatkan Keterampilan Proses Sains di Sekolah Menengah Atas. Jurnal Penelitian Pendidikan Kimia 1(1) 1-8
[16] Rauf A A, Rasul M S, Mansor A N, Othman Z & Lyndon N 2013 Inculcation of Science Process Skills in a Science Classroom. Asian Social Science 9(8) 47-57 http://dx.doi.org/10.5539/ass.v9n8p47
[17] Ilmi N, Desnita, Handoko E, Zelda B 2016 Pengembangan Instrumen Penilaian Keterampilan Proses Sains pada Pembelajaran Fisika SMA. Prosiding Seminar Nasional Fisika (E-
[18] Ramayanti S, Utari S, and Saepuzaman D 2017 Training Students’ Science Process Skills through Didactic Design on Work and Energy. *International Conference on Mathematics and Science Education (ICMScE) IOP Conf. Series: Journal of Physics: Conf. Series* **895** doi:10.1088/1742-6596/895/1/012110

[19] Setiawan C, Tanggyong A F, Belen S, and Matahelemual Y 1988 *Pendekatan Keterampilan Proses* (Jakarta: PT Gramedia)

[20] Nahadi, Firman H, dan Khilda K 2017 Pengembangan Instrumen Penilaian Diri dan Penilaian Teman Sejawat untuk Menilai Kinerja Siswa SMK pada Praktikum Kimia. *Jurnal Penelitian Pendidikan Kimia* **4(2)** 111-118

[21] El-Koumy, A K 2010 *Student selfassessment in higher education:alone or plus?*. (Lebanon: Lebanese American University)