Development of testlet instruments to measure science process skills on static fluid

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Abstract. Science process skills cannot be separated from conceptual learning. To measure science process skills possessed by students, assessment instruments are needed that are easy to use and appropriate. This study aims to measure the science process skills of high school students using the Testlet assessment instrument. Indicators The science process skills used are observing, hypothesizing, planning experiments or investigations, analyzing experimental data, applying concepts or principles, and communicating. This assessment instrument Testlet consists of 6 stem and 3 supporting questions for each stem, questions in the form of multiple choices and given to 36 grade XI students at Madiun 4 High School. The results of this study indicate the Science Process Skills of students at SMA 4 Madiun on static fluid material included in the medium category with an average value of 63.51%.

1. Introduction

Science process skills are important for each individual as a basic capital for someone to solve problems in everyday life. SPS involves intellectual, manual, and social skills that are used to build an understanding of a concept or knowledge and convince or perfect understanding that has been formed [1]. Physics with its characteristics is one medium that is good enough to know students' science process skills. In the learning process, the right method is needed and in accordance with the subject matter being studied so that SPS abilities can be possessed by students.

Science process skills have facilitated science learning, student activities, and increased student responsibility for learning, and taught students scientific methods or research [2]. In addition, this study was also used by researchers in their studies. This skill is suitable for all fields of science, more important for students is how to learn to apply science in actual learning in everyday life, apply concepts, to apply theory and law in learning. This is more needed for students to make it a habit of science process skills.

Ways to improve the quality of education can be done by improving the quality of learning and the assessment system, a good learning system will produce good quality learning, all of this can be seen from the results of their assessment. A good assessment system will encourage teachers to determine good learning strategies to motivate students to learn better. Assessment is a systematic and continuous process to gather information about the success of students and is useful for increasing the effectiveness of learning [3]. Assessment includes all the methods used to assess individual performance. Assessment focuses on individuals, namely learning achievement achieved by individuals [4].
Develop an assessment instrument which is a science process skill test instrument and consists of open ended questions that are presented in the form of multiple choices, as well as other assessment instruments in the form of product presentation evaluations. From the results of the study concluded that the project-based learning method is more effective to provide an assessment of science process skills. Based on the conclusions in the study, one method in training SPS that can be used by the author as a reference is a project-based learning model [5].

Testlet is a set of questions that reveal the same information where the items in question are considered and treated as a single unit of matter [6-9]. The design of a testlet instrument is a set of items that provide a stimulus. This has been widely used in the world of education and psychological testing. Many test developers find this testlet design interesting because it is efficient in writing items. In science some topics are hierarchical [10, 11]. Generally the teachers still do not fully understand the testlet assessment instrument as an assessment instrument of science process skills. Scientific learning that has been done by the teacher cannot provide correct information if it is not supported by the ability to measure it. Testlet instruments are present to familiarize students to solve problems by using Science Process Skills.

Testlet is suitable to be used for questions that are related to concepts and are hierarchical. In connection with the understanding of science process skills that require assessment of science process skills so that learning is not in vain and weighs material in overlapping and hierarchical sciences, it is suspected that testlet instruments that have the characteristics of hierarchical instruments and are prepared based on indicators of science process skills will be able to display student profiles with the results of different science process skills [12-14]. The construction of hierarchical questions like this makes it possible to apply the GRM model. GRM is one of the models developed by Samejima to handle scoring on politomus items. With the GRM scoring the teacher can look at the students' science process skills as well as the description questions but scoring testlet questions is more efficient because it is objective and politomus [15]. The process of scoring using the GRM method is as shown in table 1.

| Assessment Aspect                                      | Skor |
|--------------------------------------------------------|------|
| Students cannot solve supporting questions number 1 correctly | 0    |
| Students can solve supporting questions number 1 correctly, but cannot solve supporting questions number 2 | 1    |
| Students can solve supporting questions number 1 and number 2 correctly, but cannot solve supporting questions number 3 | 2    |
| Students can complete all supporting questions correctly | 3    |

In science teaching and learning process, especially in physics lessons it is very important to know the science process skills possessed by students. One of the usual assessments made by teachers is assessment with multiple choice tests or esay. Assessment in the form of multiple choice and esay still has some deficiency in its application to the assessment activities. In the development of assessment tests generally focus on cognitive aspects, without considering the student science process skills. This causes the concepts to be less internalized to students' minds because they are required to only memorize, not to do the process of digging up information. Thus, the purpose of this study is to measure the science process skills of high school students by using the Testlet assessment instrument.

2. Methods
This research is a research and development study consisting of three main stages, those are: the preliminary stage, the development stage and the evaluation phase. The preliminary stage in this study consists of an analysis of initial needs in the form of observations, interviews, and also the distribution of questionnaires at the research location. The development stage in this research is based on the results of preliminary analysis. At this stage, the initial product that has been made is validated by experts. This is done to get a good quality product. The last stage is the evaluation phase, with disseminate the instruments that have been developed for respondents. This research was conducted at
Madiun 4 High School. Respondents in this study were students of class XI IPA 1 who had received static fluid material as many as 36 students.

The data collection technique used in this study was through a test question instrument consisting of 18 multiple choice Testlet items. From the results of this data analysis we will find out how the science process skills of students in static fluid material. The collected data will be processed with percentage interpretation data processing techniques. Taking the score obtained is calculated using a formula and converted on a percentage scale (0% - 100%). The formula used is as follows:

\[ P(\%) = \frac{\sum \text{Score obtained (x)}}{\sum \text{Maximum score (n)}} \times 100\% \]

The percentage value obtained will be adjusted to the following table:

| Value (%)          | Information |
|--------------------|-------------|
| >75 - 100          | High        |
| >50 - 75           | Fair        |
| >25 - 50           | Low         |
| 0 - 25             | Very Low    |

Table 2 shows the percentage scale for categorizing the science process skills acquired by students. If the value obtained by students >76 -100 means that the student has a high science process skills, if the value obtained of >51 -75 means science process skills is fair, if the value obtained of >26 -50 then the science process skills is low, and if the value obtained is 0-25 means that the student has a science process skills is very low.

3. Result and Discussion
This study aims to measure the science process skills of high school students using the Testlet assessment instrument. Based on the preliminary research and literature review, it was concluded that in order to increase the quality of learning required an development of assessment instruments that not only have advantages such as instruments in the form of descriptions that have advantages in knowing the problem solving process, are able to measure students' abilities more deeply and able to minimize students in guessing answers. In addition, it is not only limited to the ease of correction, such as multiple choice instruments. The lack of instruments used by teachers that can be used to measure students' Science and Cognitive Process Skills at the same time adds to the importance of this research and development. In this study the prepared instruments were tested on 36 students of Madiun 4 High School. The results of this study besides being used to analyze items, can also function to find out the SPS that students have.

The Testlet instruments developed consisted of 6 main Stem, each Stem had 3 supporting question the third supporting question was a hierarchical question, meaning students could not answer question number 3 correctly without going through questions number 1 and 2. Construction of hierarchical questions like this allows to implement the GRM model. The effect of applying the GRM model in the construction of the Testlet questions is that the teacher or user of the problem can find out the extent to which the knowledge process possessed by students, which is meant in this research is the science process skills possessed by students. In this Testlet instrument every question is made tiered, the first question of each Stem is a basic concept problem that should have been easy and understood by students. The next 2 questions are development questions from the main concepts to train students' thinking skills. This research develops Testlet instruments which are combined with indicators of science process skills, so that in addition to knowing students' cognitive abilities, this instrument can also provide an overview of the science process skills possessed by students. The results of the SPS Analysis at this stage are presented in table 3.
### Table 3. Indicator completeness of students' science process skills

| Indicators of Science Process Skills | SPS completeness (%) |
|-------------------------------------|----------------------|
| Observe                             | 76.67                |
| Hypothesize                         | 59.92                |
| Planning an experiment or investigation | 62.96            |
| Analyze experimental data           | 48.81                |
| Apply concepts or principles        | 76.67                |
| Communicate                         | 56.02                |

Table 3 shows the almost equal distribution of students. Indicators observe and apply concepts or principles to get the highest percentage. This proves that students actually know the basic concepts of static fluid and can observe also distinguish. However, for indicators analyzing experimental data, get the lowest percentage of answers. This can be because students only know the basic concepts of static fluid material, but when students are faced with a new problem situation, where students must determine the influential variables and analyze the data that there are students still experiencing difficulties. The results of this test can also be used to categorize students based on their Science Process Skills. In this study, the categorization of students was divided into 4 namely students who had high, medium, low and very low SPS. The student SPS percentage data is presented in Figure 1.

![Figure 1](image.png)

**Figure 1.** Percentage of Science Process Skills in the aspect of indicators

Figure 1 shows the percentage of science process skills in the indicator aspect. Indicators observe and apply concepts or principles in the high category of 76.67%. The 3 indicators included in the medium category, namely the hypothesizing indicator which was 59.92%, the indicator planning an experiment or investigation was 62.96%, and the indicator communicating at 56.02%. As well as 1 PPP indicator that is included in the low category is analyzing the experimental results data that is equal to 48.81%. Based on the data analysis of science process skills students in static fluid material can be seen in SMA 4 Madiun included in the medium category with an average value of 63.51%.

### 4. Conclusion

In this study using alternative instruments to measure the assessment of science process skills, namely using testlet instruments. The results of the science process skills analysis used six indicators from this study indicates that students show positive results in observing indicators, and applying concepts or principles. However, for indicators analyzing experimental data, get the lowest percentage of answers. This can be because students only know the basic concepts of static fluid material, but when
students are faced with a new problem situation, where students must determine the influential variables and analyze the data that there are students still experiencing difficulties. Therefore it is necessary to provide instruments that can encourage students to think scientifically, so that students have the knowledge of observing, hypothesizing, planning experiments or investigations, analyzing experimental data, applying concepts or principles, and communicating.

5. References
[1] Hasibuan J J and Moedjiono 2000 Proses Belajar Mengajar (Bandung: PT. Remaja Rosdakarya)
[2] Karamustafaoglu S 2011 Improving the science process skills bility of prospective science teachers using I diagrams. Eurasian J. Phys. Chem. 3 1 p.26-38
[3] Basuki I and Hariyanto 2014 Asesmen Pembelajaran (Bandung: PT Remaja Rosdakarya Offset)
[4] Mansyur, Rasyid, and Suratno 2015 Asesmen Pembelajaran di Sekolah (Yogyakarta: Pustaka Belajar)
[5] Özer D Z and Özkan M 2012 The Effect of the Project Based Learning on the Science Process Skills of the Prospective Teachers of Science. Journal of Turkish Science Education, 9 3
[6] Embretson S E and Reise S P 2000 Item Response Theory for Psychologist (New Jersey: Lawrence Erlbaum Associates)
[7] Shidiq A S Yamtinah S and Masykuri M, 2019 Identifying and addressing students’ learning difficulties in hydrolysis using testlet instrument AIP Conf. Proc. 2194, 020117 p. 1–8.
[8] Ratna I S Yamtinah S Ashadi Masykuri M and Shidiq A S, 2017 The Implementation of Testlet Assessment Instrument in Solubility and Solubility Product Material for Measuring Students’ Generic Science Skills Adv. Soc. Sci. Educ. Humant. Res. 158 p. 958–963.
[9] Yamtinah S Masykuri M Ashadi M and Shidiq A S, 2017 An Analysis of Students’ Science Process Skills in Hydrolysis Subject Matter Using Testlet Instrument Proc. Int. Conf. Teach. Train. Educ. 2017 (ICTTE 2017) 158 p. 101–110.
[10] Shidiq A S, 2016, Pengembangan Instrumen Penilaian Testlet Untuk Mengukur Keterampilan Proses Sains Pada Materi Hidrolisis Garam Untuk Siswa Kelas XI SMA/MA, Universitas Sebelas Maret.
[11] Yamtinah S Masykuri M Ashadi M and Shidiq A S, 2017 An Analysis of Students’ Science Process Skills in Hydrolysis Subject Matter Using Testlet Instrument Adv. Soc. Sci. Educ. Humanit. Res. 158 p. 101–110.
[12] Shidiq A S Yamtinah S and Masykuri M, 2016 Assessing Science Process Skills using Testlet Instrument in Assessment for Improving Students’ Performance p. 231–234.
[13] Yamtinah S Saputro S Mulyani S Ulfa M Lutviana E and Shidiq A S, 2019 Do students have enough scientific literacy? A computerized testlet instrument for measuring students’ scientific literacy AIP Conf. Proc. 2194, 020143 p. 1–8
[14] Yamtinah S, Haryono, Mulyani B and Shidiq A S 2016 Pelatihan Guru Kimia SMA dalam Mengembangkan Tes Jenis Testlet dan Profil Individu untuk Mengukur Keterampilan Proses Sains Prosiding SNPS p. 161-167
[15] De Ayala R J Dodd B G and Koch W R 1989 Applied Psycho. Measurement 13 2 p. 129-143

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