A profile of senior high school students' science process skills on heat material

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Abstract. In physics learning, students need to be trained to develop Science Process Skills (SPS). This research is pre-experiment research. The main objective of this research is to analyze the profile of senior high school students' SPS on heat material. The subjects of this research were senior high school students in Indonesia. The sample of this research was 110 students of class X senior high school, first year. Determination of the sample in this research using purposive sampling. The SPS Test Instrument (SPSTI) to determine the profile of senior high school students' SPS on heat material. SPSTI consists of eight indicators: Formulating the problem; Formulate a hypothesis; Identifying experimental variables; Defines the operational definition of the experiment variable; Designing experimental procedures; Creating graph; Data analysis; Formulating conclusions. This instrument has been declared valid and reliable by the three experts. In the case of this research, the profile of senior high school students' SPS on heat material is generally still at a low level. The implication of this research can be used as empirical evidence that senior high school students' SPS on heat material still needs to be improved.

1. Introduction
Physics learning cannot be separated from the process of systematic scientific investigation. Along with its development, the process contained in scientific investigation is packaged more systematically in the form of skills that one must possess to carry out scientific investigations, these skills are known as science process skills (SPS). SPS are procedural, experimental, and systemic skills of science as the basis of science [1–7], so teachers and students need to have a good understanding of SPS [8,9].

Thus, students studying physics are not sufficient by simply remembering and understanding the physics concepts discovered by scientists, but they can behave like a scientist in discovering the concepts of physics. Students use SPS as basic skills to master physics [10,11]. SPS can be developed in learning based on a scientific approach [4,11–13].

SPS is one of the pillars in supporting mastery of physics [14]. It shows that KPS is very much needed in science learning. Science learning must facilitate how to obtain scientific information, how science,
and technology work in shaping procedural knowledge, including scientific work habits, which always
refers to investigative techniques for a phenomenon, acquiring new knowledge, or correcting and
combining previous knowledge [15]. SPS, both basic SPS and integrated SPS, must be trained to
students so that students are not only recipients of information, but can also search for information
related to the things being learned. The results showed that when the initial SPS were low [3,6,16], it
would hamper the physics learning process in the classroom.

Reviewing the importance of SPS for high school students. So there is a need for research that focuses
on looking at the profile of senior high school students' SPS, especially in heat material. The results of
this study are expected to be empirical evidence in the development of research in the field of physics
education, especially SPS.

2. Method
2.1 General Background of Research
This research is pre-experiment research. The main objective of this research is to analyze the profile of
senior high school students' SPS on heat material.

2.2 Sample of Research
The subjects of this research were senior high school students in Indonesia, and the sample was 110
students of class X senior high school, first year. Determination of the sample in this research using
purposive sampling.

2.3 Procedure
This research procedure consisted of: (1) the researcher conducted a literature study related to SPS; (2)
the researcher focuses on finding indicators and assessments of SPS in the field of physics; (3)
researchers developed a draft Science Process Skills Test Instrument (SPSTI) to determine the profile
of senior high school students' SPS on heat material; (4) the researcher gave three experts to validate the
SPSTI; (5) The researcher revised based on input from the three validator experts; (6) The researcher
measured 110 students using the SPSTI to determine the profile of senior high school students' SPS on
heat material; (7) the researcher conducted an analysis and conclusions based on the results of the SPSTI.

2.4 Instruments
In this research, using the SPSTI to determine the profile of senior high school students' SPS on heat
material. SPSTI consists of eight indicators: Formulating the problem; Formulate a hypothesis;
Identifying experimental variables; Defines the operational definition of the experimental variable;
Designing experimental procedures; Creating graph; Data analysis; Formulating conclusions. This
instrument has been declared valid and reliable by the three experts. Validation results of SPSTI in Table
1.

| Item of SPSTI | Validity Score | Validity   | Reliability |
|--------------|----------------|------------|-------------|
| Item 1       | 4.00           | Very Valid | Reliable    |
| Item 2       | 4.00           | Very Valid | Reliable    |
| Item 3       | 4.00           | Very Valid | Reliable    |
| Item 4       | 4.00           | Very Valid | Reliable    |
| Item 5       | 4.00           | Very Valid | Reliable    |
| Item 6       | 3.67           | Very Valid | Reliable    |
| Item 7       | 4.00           | Very Valid | Reliable    |
| Item 8       | 4.00           | Very Valid | Reliable    |

The test instrument for the SPSTI to determine the profile of senior high school students' SPS on heat
material by the experts on average is very valid and reliable.

2.5 Data Analysis
Profile of senior high school students' SPS on heat material was analyzed by using qualitative descriptive. The results of this analysis will be used to obtain the initial profile of senior high school students' SPS on heat material. In the next section, we will use it to make recommendations in physics learning based on SPS.

3. Results and Discussion
After the SPSTI instrument was declared valid and reliable by three experts, it was then tested on 110 senior high school students taking physics subjects. In summary, the analysis of the results of senior high school students' SPS on heat materials is presented in Table 2.

| ST | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
|----|---------|---------|---------|---------|---------|
| S  | C       | IC      | S       | C       | IC      | S       | C       | IC      | S       | C       | IC      |
| S1 | 0.88    | L       | 0       | NC      | 0.50    | L       | 0       | NC      | 0.50    | L       | 0       | NC      | 0.50    | L       | 0       | NC      |
| S2 | 1.00    | L       | 0       | NC      | 0.50    | L       | 0       | NC      | 0.50    | L       | 0       | NC      | 0.50    | L       | 0       | NC      |
| S3 | 1.00    | L       | 0       | NC      | 0.38    | L       | 0       | NC      | 0.38    | L       | 0       | NC      | 0.38    | L       | 0       | NC      |
| S4 | 1.00    | L       | 0       | NC      | 0.50    | L       | 0       | NC      | 0.50    | L       | 0       | NC      | 0.50    | L       | 0       | NC      |
| S5 | 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S6 | 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S7 | 0.50    | L       | 0       | NC      | 0.38    | L       | 0       | NC      | 0.38    | L       | 0       | NC      | 0.38    | L       | 0       | NC      |
| S8 | 0.50    | L       | 0       | NC      | 0.38    | L       | 0       | NC      | 0.38    | L       | 0       | NC      | 0.38    | L       | 0       | NC      |
| S9 | 0.50    | L       | 0       | NC      | 0.38    | L       | 0       | NC      | 0.38    | L       | 0       | NC      | 0.38    | L       | 0       | NC      |
| S10| 0.50    | L       | 0       | NC      | 0.38    | L       | 0       | NC      | 0.38    | L       | 0       | NC      | 0.38    | L       | 0       | NC      |
| S11| 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S12| 0.33    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S13| 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S14| 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S15| 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S16| 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S17| 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S18| 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S19| 0.13    | L       | 0       | NC      | 0.13    | L       | 0       | NC      | 0.13    | L       | 0       | NC      | 0.13    | L       | 0       | NC      |
| S20| 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S21| 0.38    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.25    | L       | 0       | NC      |
| S22| 0.63    | L       | 0       | NC      | 0.50    | L       | 0       | NC      | 0.25    | L       | 0       | NC      | 0.13    | L       | 0       | NC      |
| A  | 0.51    | L       | 0       | NC      | 0.32    | L       | 0       | NC      | 0.30    | L       | 0       | NC      | 0.29    | L       | 0       | NC      |

Note: ST: Student Initial; S: Score; C: Criteria; IC: Indicator Completeness; NC: Not Complete; A: Average

Based on Table 2, it has been shown that students' SPS on heat material are in the low category in all classes. As many as 110 students did not have a score above 1.00. All students also did not achieve completeness for the SPS indicator on heat material.

| Indicators of SPS | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
|-------------------|---------|---------|---------|---------|---------|
|                   | S       | C       | IC      | S       | C       | IC      | S       | C       | IC      | S       | C       | IC      |
| 11                | 1.00    | Low     | NC      | 1.00    | Low     | NC      | 1.00    | Low     | NC      | 1.00    | Low     | NC      |
| 12                | 1.00    | Low     | NC      | 0.90    | Low     | NC      | 0.90    | Low     | NC      | 0.90    | Low     | NC      |
| 13                | 0.40    | Low     | NC      | 0.30    | Low     | NC      | 0.20    | Low     | NC      | 0.20    | Low     | NC      |
| 14                | 0.20    | Low     | NC      | 0.20    | Low     | NC      | 0.20    | Low     | NC      | 0.20    | Low     | NC      |
| 15                | 1.00    | Low     | NC      | 0.00    | Low     | NC      | 0.00    | Low     | NC      | 0.00    | Low     | NC      |
| 16                | 0.10    | Low     | NC      | 0.00    | Low     | NC      | 0.00    | Low     | NC      | 0.00    | Low     | NC      |
| 17                | 0.20    | Low     | NC      | 0.00    | Low     | NC      | 0.00    | Low     | NC      | 0.00    | Low     | NC      |
| 18                | 0.20    | Low     | NC      | 0.10    | Low     | NC      | 0.10    | Low     | NC      | 0.10    | Low     | NC      |

Note: ST: Formulating the problem; I2: Formulate a hypothesis; I3: Identifying experimental variables; I4: Defines the operational definition of the experimental variable; I5: Designing experimental procedures; I6: Creating graph; I7: Data analysis; I8: Formulating conclusions; NC: Not Complete; S: Score; C: Criteria

SPSTI consists of eight indicators: Formulating the problem; Formulate a hypothesis; Identifying experimental variables; Defines the operational definition of the experimental variable; Designing experimental procedures; Creating graph; Data analysis; Formulating conclusions. All indicators are
still in the low and incomplete category. It shows that the profile of senior high school students' SPS on heat material is still low.

The low level of SPS could be due to: (1) The teacher does not maximally train the students' skills; (2) The teacher does not understand SPS; (3) Students do not pay serious attention when being trained in SPS; (4) tools and materials do not support SPS-based learning; (5) students are still less motivated in learning physics using SPS because the exams administered by the teacher are knowledge-based; (6) Teachers do not accommodate SPS in the implementation of exams; (7) SPS are not used as a reference in examinations carried out in national exams so that students are less enthusiastic; (8) support from the school still lacks because it is oriented towards the mastery of knowledge only; (9) there is no appropriate teaching material for use by teachers; (10) teachers feel they do not have time to develop innovative teaching and learning materials that specifically train SPS. SPS include a scientific approach in teaching physics that is based on the results of observations and experiments as carried out by scientists [17,18]. The results of this study indicate that students are still very weak in implementing the SPS, especially in heat material. An alternative solution to the problem of the low SPS is to implement physics learning which by design has been proven valid, practical, and effective to improve students' SPS.

Solutions to overcome the problem of low SPS by applying or developing research results that have been proven to be effective in improving SPS are as follows: (1) Familiarization of SPS including instructional objectives (impact) Creative Responsibility Based Learning [17-19]; (2) Inquiry-based learning is proven to be effective in improving SPS [5,17,19–22]; (3) ADDIE Learning Model [23]; (4) the use of quality learning media and teaching materials [24–29]; (4) Discovery-based learning is proven to be effective in improving SPS [30–33]. There have been many alternative solutions that can be used for teacher adaptation. Teachers still need to modify based on the characteristics of students in Indonesia, because differences in social, cultural, language and infrastructure backgrounds will affect the effectiveness of learning innovations that will be used to improve the SPS of senior high school students, especially in heat material.

4. Conclusion
In the case of this research, the profile of senior high school students' SPS on heat material is generally still at a low level. The implication of this research can be used as empirical evidence that senior high school students' SPS on heat material still needs to be improved. The limitations of this research are still using 110 senior high school students. Further research needs to be done to solve the problem of the low level of senior high school students' SPS on heat material.

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