The Generic Science Skill Profile of High School on Theory
Momentum And Impulse

M T Sakliressy*, W Sunarno, F Nurosyid
Program Magister Pendidikan Fisika Universitas Sebelas Maret, Jl. Ir. Sutami 36A
Keningan, Jebres, Surakarta 57126, Indonesia
*Corresponding author’s email: mauratrynovita@student.uns.ac.id

Abstract. So many jobs today require high-level skills, logical thinking, creative thinking, generic and scientific processes, being able to solve problems, and make decisions. These skills are one of the main goals of 21st-century learning. Based on the results of a survey by TIMSS (Third International in Mathematics and Science Study) students in Indonesia in the field of science are ranked 38 out of 40 countries. This study aims to describe the generic science skill profile of YPPK Teruna Bakti high school students class XI on momentum and impulse. The method used in this research is descriptive quantitative. Data were collected through a test method in the form of multiple-choice questions based on three of the nine generic science skills indicators according to Brotosiswoyo. The test was conducted on 35 students. The test results showed that the overall average level of mastery was 55.7%. Generic science skills per indicator, for direct observation indicators 59.5%, concept building indicators 55.7%, logical consistency indicators 51.4%. The overall average for the concept of momentum and impulse is 60%, the concept of momentum-impulse relationship and the law of conservation of momentum is 52%, and the concept of collision and application impulse-momentum is 55%.

1. Introduction
Education in Indonesia is currently still being an important center of attention along with the development of science and technology [4]. There is an increasing number of jobs nowadays that require high-level skills, logical thinking, creative thinking, generic and scientific processes, problem-solving, and decision-making ability. These skills are one of the main goals in 21st-century learning and in our country, the mastery of these skills is still relatively low. This is supported by the results of a survey by TIMSS (Third International in Mathematics and Science Study); students in Indonesia in the field of science are ranked 38 out of 40 countries [11].

Physics learning can foster students’ thinking abilities and skills which can be developed through active involvement with teachers, peers, and the environment using experiments. This is done so that students can use scientific methods that are based on scientific attitudes and generic science skills (GSS) to solve problems they might encounter both in learning and the community. This is following Brett, Mark, and Craig who stated that students with generic proficiency have good career prospects [13]. Basic abilities of generic skills are abilities that are general and oriented towards higher knowledge and can be applied to a wider job application. As stated by Sudarmin, the prerequisite for mastery of high-level thinking skills are generic science skills [12].

Generic science skills are necessary skills that students must possess so that the knowledge and expertise gained in the learning process can be applied in everyday life and respond to the challenges of an increasingly fast-developing era, especially in the fields of science and technology [10]. According
to Brotosiswoyo, generic science skills are something that is instilled after learning science [10]. According to Bailey, the main reason for the importance of the development of generic skills is that they are categorized into basic and general skills. Also, generic skills are flexible and oriented as a provision to study at a higher level, or to serve a wider field of work, not only within the area of expertise but also in other fields [1]. Generic skill indicators according to Brotosiswoyo, as formulated in the table below.

Table 1. Indicators of Generic Science Skills [10]

| No | GSS Indicators          | Indicators                                                                 |
|----|-------------------------|---------------------------------------------------------------------------|
| 1  | Direct observation      | a. Using as many senses as possible in observing experiments / natural phenomena  |
|    |                         | b. Gathering facts from experiments or natural phenomena                    |
|    |                         | c. Looking for differences and similarities                                |
| 2  | Indirect observation    | a. Using a measuring instrument as a sensory aid in observing experiments / natural phenomena  |
|    |                         | b. Gathering facts that are the result of physical experiments or natural phenomena |
|    |                         | c. Looking for differences and similarities                                |
| 3  | Awareness of scale      | Recognizing natural objects and having a high sensitivity to numeric scales as microscopic or macroscopic scales measures |
| 4  | Symbolic language       | a. Understanding sign, symbols, and terms                                    |
|    |                         | b. Understanding the quantitative meaning of units and quantities of equations |
|    |                         | c. Using mathematical rules to solve problems / natural phenomena             |
|    |                         | d. Reading graphs/diagrams, tables, and mathematical signs                    |
| 5  | Logical framework       | Looking for a logical relationship between the two rules                     |
| 6  | Logical consistency     | a. Understanding rules                                                       |
|    |                         | b. Presenting arguments following the rules                                  |
|    |                         | c. Describing problems based on the rules                                    |
|    |                         | d. Drawing conclusions from a phenomenon based on previous rules or laws      |
| 7  | The law of cause and effect | a. Stating the relationship between two or more variables in a certain natural phenomenon |
|    |                         | b. Estimating the causes of natural phenomena                               |
| 8  | Mathematical modeling   | a. Displaying phenomena/problems in the form of drawing or graphic sketches   |
|    |                         | b. Proposing alternative solutions to problems                               |
| 9  | Concept building        | Adding new concept                                                          |

The benefits of using generic science skills as a foundation in learning include: helping teachers improving student learning outcomes, accelerating the achievement of learning goals, being able to regulate the speed of learning, and sharpening the higher-level thinking skills. This is in line with Pujani
statement, in which researchers said that the benefits that can be obtained by using generic science skills as a foundation in IPBA practicum learning include: (1) Generic science abilities help teachers improve student learning; (2) Learning that takes the generic abilities of science into account can accelerate learning progress, and (3) Students who practice generic science skills can set their learning speed or set by the teacher based on the desirable speed of learning [6].

Based on this background, the problem in this research is what is the profile of students’ generic science skills on indicators of direct observation, concept-building, and logical consistency. The purpose of this article is to describe the generic science skill profile in XI grade high school students on momentum and impulse material. Momentum and material impulses include: momentum, impulse, momentum and impulse relationship, the law of conservation of momentum, collisions, and impulse-momentum applications

2. Methods
The method used to determine generic science skills in this research is descriptive quantitative. The subjects of this study were 35 students of grade XI SMA YPPK Teruna Bakti. Data were obtained through a test instrument using 20 multiple choice questions utilizing three indicators from nine indicators according to Brotoisiswoyo. The three indicators include 7 direct observation indicators, 7 concept building indicators, and 6 logical consistency indicators. The questions of momentum and impulse are divided into three sub-materials, namely momentum and impulse consisting of 7 questions, the momentum-impulse relationship and the law of conservation of momentum consisting of 7 questions, and the types of collisions and the application of momentum-impulse consists of 7 questions. The answer to each question is assessed using the Guttman rubric scale with certain criteria. If the answer is correct, then the score is 1 and if the answer is wrong then the score is 0.

After the data has been collected, it is analyzed using descriptive analysis techniques in the form of a percentage calculated using the following formula [7].

\[ NP = \frac{R}{SM} \times 100\% \]

Remarks:
NP = percent value
R = score obtained
SM = ideal maximum score

The research data then grouped into five categories: very good, good, sufficient, insufficient, very poor, with the following grouping criteria:

Table 2. Categories of generic science skills [8]

| Categories     | Mastery rate (%) |
|----------------|------------------|
| Very Good      | 86 – 100         |
| Good           | 76 – 85          |
| Sufficient     | 60 – 75          |
| Insufficient   | 55 – 59          |
| Very Poor      | \leq 54          |

3. Results and Discussion
The following are the results of research data analysis and discussion:

Table 3. Generic Science Skills for students as a whole

| Categories     | Total students | Mean (%) |
|----------------|----------------|----------|
| Very Good      | 0              | 55,7     |
| Good           | 2              |          |
| Sufficient     | 15             | (Insufficient) |
| Insufficient   | 10             |          |
| Very Poor      | 8              |          |
Table 3 shows the average achievement of generic science skills as a whole is 55.7% which is in the insufficient category. Based on the figures and results in table 3, it is clear generic science skills still need to be improved. This is because students are just starting to develop their GSS through learning which is expected to involve them more directly, for example in experiments. Therefore the student becomes actively involved in the learning process. In line with Sudarmin's opinion, generic science skills can be developed to provide meaningful experiences through problem solving and experimentation [9].

Table 4. Generic Science Skills for students as a whole

| GSS aspect         | Mean (%) | Category  |
|-------------------|----------|-----------|
| Direct observation| 59.5     | Insufficient |
| Concept building  | 55.7     | Insufficient |
| Logical consistency| 51.4    | Very poor  |

Figure 1. Results of GSS in students as a whole

Figure 2. The average yield of GSS on students per indicator

Table 4 shows the average attainment of generic science skills per indicator. The first indicator is a direct observation with the level of mastery of 59.5% which is within the insufficient category, the
second indicator is concept building with the level of mastery of 55.7% which is included in the insufficient category, the third indicator is logical consistency, the level of mastery is 51.4% which is within the very poor category. In direct observation indicators, the level of mastery is still higher than the indicators of building concepts and logical consistency. This is because students are still lacking in determining and differentiating concepts and everyday life applications. This is in line with Yohana's research on generic science skills for logical consistency resulted in a score of 67. That is, in this particular skill aspect, students are placed in the medium category because most of them are still lacking in determining acidity and distinguishing strong bases and weak bases when associated with everyday life [12].

Based on the results shown in tables 3 and 4 it is clear that students’ generic science skills need improvement because the three indicators tested indicate that students' GSS is still in the poor category. This is following Zulfiani & Octafiani's research that generic science skills must be continuously trained so that students get used to it and thus their GSS can be increased [13]. The role of teachers in education innovation will be very impactful in efforts to improve generic science skills. Learning must be centered on students so that they experience and find their concepts, hence they can solve problems in the given physics problems. The models and methods used must also be able to actively involve students so that the thinking skills and other skills they get in the learning process are continuously refined. This is in line with research conducted by Khoiri & Zulfiyah [2] and Kusdiwelirawan et al [3] that the inquiry learning model and PBL (Problem Based Learning) centered around students can improve their generic science skills.

| No | Concept                                      | Mean (%) | Category       |
|----|----------------------------------------------|----------|----------------|
| 1  | Momentum and impulse                         | 60       | Sufficient     |
|    | The momentum-impulse relationship and the law of conservation of momentum | 52       | Very poor      |
| 2  | Type of collision and momentum-impulse application | 55       | Insufficient   |

**Table 5. Mastery of the overall concepts of momentum and impulse**

![Figure 3. The average results of the mastery of the concepts of momentum and impulse](image-url)
Table 5 shows that the overall mean percentage of students on the concepts of momentum and impulse, namely 60% which is in the sufficient category, the concept of momentum-impulse relationship and the law of conservation of momentum, namely 52% which is in the very poor category, as well as the concept of collision and impulse-momentum application, that is 55% which is in the insufficient category.

Based on the results in Table 5 and Figure 3, it can be seen that the mastery of the concepts of momentum and impulse still needs to be improved, especially in the concept of the momentum-impulse relationship and the law of conservation of momentum, as well as collisions and the application of momentum-impulses which is within insufficient and very poor categories. This is because, in the concept of momentum-impulse relationship and the law of conservation of momentum, the material is more extensive and broad so that students need to allocate more time than other concepts. The students’ mastery of the concept of collision and the application of momentum-impulse is also quite low because in the learning process students had not been actively involved and thus connecting physics concepts and daily life application has not been fully mastered. This is in line with Pujani et al, who said that science education research shows that students' understanding increases when learning strategies that involve activities in the learning process were applied. Therefore, the active involvement of students in learning will lead to increased mastery of generic science concepts and skills [5]. Several studies conducted by Freeman et al; Saprudin et al; Wijaya & Ramales; Anwar; and Harahan et al show that active learning is very effective in developing students' mastery of generic science concepts and skills [5].

4. Conclusion

The generic science skills of YPPK Teruna Bakti high school students on impulse-momentum showed that the overall level of mastery of GSS as a whole was still lacking. This is also seen from the average generic science skills per indicator, including direct observation indicators, concept-building, logical consistency, and the overall average of students on the concept of momentum and impulse, momentum-impulse relationship, and the law of conservation of momentum, as well as collisions and application of momentum-impulses. Through this research, it is suggested to carry out further research with learning models and methods that are fun and student-centered such as the Problem Based Learning model, Discovery Learning, Guided Inquiry, and experimental or project methods. Therefore, in the physics learning process students are expected to be directly involved in experimental activities. This is done to improve generic science skills and mastery of concepts in physics lessons.

Acknowledgments

The authors express sincere gratitude and appreciation to all those who have helped in doing this research, especially to all teachers and students partaking in the data collection process.

References

[1] Alpusari, M., and Putra, R 2018 Proceeding of the 2nd URICES, p261-269.
[2] Khoiri, N., and Fauziyah, R 2020 Jurnal Penelitian Pembelajaran Fisika, 11(1), 63.
[3] Kusdiwelirawan, A., Hartini, T. I., and Najihah, A. R Jurnal Fisika Dan Pendidikan Fisika, 1(2).
[4] Maknun, J 2015 American Journal of Educational Research, 3(6), 742–748.
[5] Pujani, N. M., Suma, K., Sadia, W., and Wijaya, A. F. C 2018 Jurnal Pendidikan IPA Indonesia, 7(3), 293–301.
[6] Pujani, N 2014 Jurnal Pendidikan Indonesia, 3(2).
[7] Purwanto, Ngalim 2013 Prinsip-Prinsip dan Taknik Evaluasi Pengajaran. Bandung: Remaja Rosdakarya.
[8] Riduwan 2015 Skala Pengukuran Variabel-variabel. Bandung: Alfabeta Bandung.
[9] Sudarmin., and Haryani, S 2015 International Journal of Science and Research (IJSR), 4(5), 2975–2980.
[10] Tawil., M., and Liliasari 2013 Keterampilan Berpikir Kompleks dan Implementasinya dalam
Pembelajaran IPA. In Penerbit UNM.

[11] Wijayanti, R., and Siswanto, J 2020 Jurnal Penelitian Pembelajaran Fisika, 11(1), 109.
[12] Yohana, I., Sudarmin, S., Wardani, S., and Mohyaddin, S 2018 International Journal of Active Learning, 3(2), 110-116.
[13] Zulfiani., and Octafiana, H 2016 Institutional Repository UIN Syarif Hidayatullah Jakarta.