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# Profile of Learning Experiences and Students' Scientific Inquiry Skills in Science Subjects

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***Abstract*— Indonesia's PISA results are relatively low when compared to other countries. Student learning experience is thought to be an important factor that influences students' lack of scientific inquiry skills. This study aims to describe the profile of students' learning experiences and scientific inquiry skills in science subjects. This descriptive study involved 1305 respondents from public and private high schools in West Java. The instrument used was a questionnaire consisting of 40 items to reveal student learning experiences in learning science and scientific inquiry skills tests in the form of 55 multiple choice and essay items developed based on the PISA framework with the adjustment of the junior high school science curriculum. Research data were analyzed descriptively using graphs. The results showed that some students (51.0%) stated that learning science in elementary and junior high schools was not fun, more than half (56.6%) rarely did practicum at school, and some to most students (42-75%) rarely plan and carry out experiments or scientific inquiry independently. The results of the research that have been presented indicate that the learning experience of students in learning science has not been maximal and students' scientific inquiry skills need to be improved. The implications and recommendations of the research findings are presented at the end of this article.**

***Keywords—science learning experience, scientific inquiry skills, the nature of science***

## I. INTRODUCTION

The development of science and technology as well as the acceleration of development recently has had a profound impact on human life. Various problems and socio-scientific issues that arise, such as hydraulic fracturing (fracking), climate change, and gene editing need to be resolved by applying various relevant disciplines. In an effort to solve these problems, scientific literacy is seen as an important factor that contributes to providing scientific arguments in formulating alternative solutions and determining the right solution [1-4]. As a consequence, building scientific literacy for students is important to implement through learning in schools, especially through science subjects.

Science is a very comprehensive scientific discipline because it includes three domains, namely tools and products of science, the human aspects of the scientific enterprise, and elements of knowledge production in science, known as nature of science [5]. Understanding of nature of science is an important prerequisite for scientific literacy [6-8]. This is very important for students to be able to master basic skills that are components of scientific literacy, namely explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting scientific data and evidence [9]. Lee and Tan further explains that scientific literacy is important because it can instill an understanding that scientific knowledge is tentative because it tends to be changed if there is new evidence [5]. Based on this, teachers need to pay attention to learning strategies and learning environments that support the development of students' content, procedural, and epistemic knowledge.

The essence of scientific literacy is related to understanding the nature of science [10]. One of the efforts to integrate nature of science explicitly in science learning is to use scientific inquiry which has been shown to improve students' scientific literacy [11]. Scientific investigation is an important tool for scientists to produce scientific knowledge [12]. Scientific investigation is an important tool in science learning because it makes students learn science through reliable scientific methods and processes [13,14]. In this way, students can predict, observe, describe, explain, discuss natural phenomena, and evaluate the quality of information according to the source. These skills are beneficial for students to build adequate knowledge of appropriate attributes in all sectors of society, social responsibility, and solve real problems in everyday life [1,15].

 

When viewed from the 2018 PISA results, the performance of Indonesian students in the field of science is low when compared to other countries, which is at 396 points, below the average for all countries, namely 489 [16]. The results of this assessment indicate that there are factors that contribute to the low scientific literacy of Indonesian students. Several studies reveal that the causes of low student scientific literacy include learning aspects (science learning tends to be textual and not contextual), science content (abstract material is difficult for students to understand), and students' intrinsic factors (low motivation to learn science) [17,18]. However, how the facts in the field related to student learning experiences related to scientific inquiry skills have not been reported. Student learning experience is thought to be an important factor that influences students' scientific inquiry skills. Therefore, in this article, we will describe in detail the profile of the learning experience and scientific inquiry skills of students in science subjects.

## II. METHODS

### A. Research Design

The research method used is descriptive which aims to obtain data as is about learning experiences and scientific inquiry skills, without giving treatment. This research was conducted in August-September 2019.

### B. Respondents

This study involved 1305 respondents, namely students of class X from public and private high schools in West Java. The consideration of using class X students is that they have taken science subjects during SD and SMP.

### C. Data Collection Instruments

The instrument used was a 5-scale questionnaire consisting of 40 items to reveal students' learning experiences in learning science. The questionnaire made includes questions about the motivation to learn science, the frequency of practicum, preparation of investigations, the implementation of investigation activities, activities that support the investigation, activities outside the classroom, learning resources, and facilities.

In addition, a scientific inquiry skills test was used in the form of 55 multiple choice items and essays developed based on the PISA framework which included the skills to explain phenomena scientifically, evaluate and design scientific investigations, and interpret scientific data and evidence [9] with adjustments to the SMP science curriculum in the revised 2013 Curriculum. The test instrument has been tested for its logical validity by involving assessment experts and practitioners. The validity of the instruments was analyzed through the Item Response Theory with the Winstep Rasch Model program with the point measure correlation in the range 0.35 to 0.58, and measures in the range -0.62 to 0.80.

### D. Research Procedure

This research was carried out in four main stages, namely preparation, development, implementation and analysis. In the preparation stage, a framework was developed (based on PISA competencies that are adjusted to the national curriculum), compiled a test blueprint questionnaire, and prepared a test blueprint for scientific inquiry skills. At the development stage, the expert validates the instruments and revises the instruments. At the implementation stage, data collection through filling out questionnaires and tests by respondents. At the analysis stage, scoring, tabulation, data analysis and interpretation of the results of the analysis were carried out.

### E. Data Analysis

Research data obtained from questionnaires and tests were analyzed descriptively and presented using tables or graphs so that data trends could be analyzed in each aspect. The research data in the form of the average score obtained from the test are interpreted based on the following categories (Table 1).

TABLE I. CATEGORIES OF SCIENTIFIC INQUIRY SKILLS TEST SCORES (ADAPTED FROM: PRASTIKA ET AL., [19]).

| Score | Category |
|---|---|
| 100 > x > 80 | Very Good |
| 80 > x > 65 | Good |
| 65 > x > 55 | Sufficient |
| 55 > x > 40 | Low |
| x < 40 | Very Low |

## III. RESEARCH RESULTS

The results showed that the mean score of the students' scientific inquiry skills test was 56.42. This shows that the scientific inquiry skills of junior high school students are classified as "sufficient".

Based on the results of the student questionnaire, it can be seen that the parents' education with the three largest percentages are SMA, S1 and S2. The parental education profile is presented in Table 2. The data in Table 2 does not indicate a tendency that the educational background of parents plays a role in the achievement of students' scientific inquiry skills.

TABLE II. PROFILE OF PARENTS' EDUCATIONAL BACKGROUND

| Educational Stage | Father | | Mother | |
|---|---|---|---|---|
| | *Percentage* | *Average Score* | *Percentage* | *Average Score* |
| SD | 3.4 | 55.80 | 4.3 | 56.54 |
| SMP | 3.7 | 56.34 | 5.6 | 55.00 |
| SMA | 32.1 | 56.28 | 36.4 | 56.20 |
| D1 | 1.8 | 57.14 | 2.7 | 57.84 |
| D2 | 0.8 | 58.89 | 0.9 | 56.09 |
| D3 | 8.9 | 56.66 | 14.0 | 57.73 |
| S1 | 29.7 | 57.60 | 26.6 | 57.69 |
| S2 | 11.7 | 57.26 | 5.2 | 55.65 |
| S3 | 2.4 | 54.62 | 0.4 | 55.00 |

The results of this study indicate that more students choose the study table as a place to study (Table 3). However, wherever they study it is less related to the achievement of students' scientific inquiry skills.

TABLE III. STUDENT LEARNING PLACES

| Place to Learn | Percentage | Average Score |
|---|---|---|
| Desk | 52.7 | 56.97 |
| Dining Table | 1.8 | 56.27 |
| Living Room | 8.7 | 57.57 |
| Floor | 14.3 | 56.15 |
| Other Places | 16.8 | 56.06 |

The results of this study indicate that some students have several scientific inquiry tools in their home (Table 4). The most common probe tool they have is a thermometer.

TABLE IV. INQUIRY TOOLS STUDENTS HAVE AT HOME

| Inquiry Tool | Percentage | Average Score |
|---|---|---|
| Thermometer | 34,92 | 56.24 |
| Loop | 23,99 | 57.84 |
| Balance | 9,77 | 57.10 |
| Microscope | 3,91 | 56.45 |
| Veterinary surgical tools | 1,10 | 56.09 |
| Do not have | 26,38 | 56.15 |

Regarding the learning resources that students have at home, most students have textbooks and other scientific books. However, the number of students who have encyclopedias and science dictionaries is still small. Even though most of the students had learning resource books, most of them (63.77%) admitted that they rarely read and used these source books. The data in Table 5 does not show a tendency that the ownership of science books plays a role in the achievement of students' scientific inquiry skills.

TABLE V. SCIENCE BOOKS OWNED BY STUDENTS

| Owned science books | Percentage | Average Score |
|---|---|---|
| Science Textbook | 43.2 | 57,12 |
| Scientific book | 32.6 | 56,78 |
| Science Encyclopedia | 16.6 | 57,27 |
| Science Dictionary | 7.5 | 56,86 |

The results of research relating to the learning experiences of students in SD and SMP are presented in Figure 1.

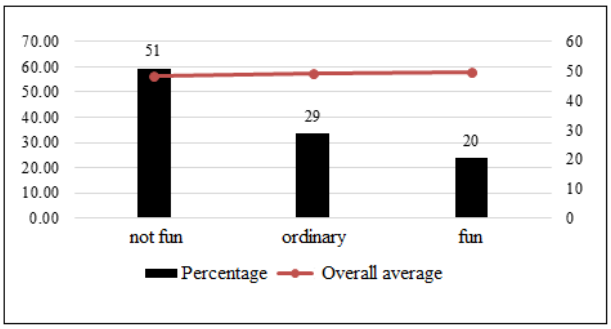


Fig. 1. Science learning experience in SD and SMP.

Based on Figure 1, it appears that some respondents stated that the science learning experience at SD and SMP was the least enjoyable. Although, the data in Figure 1 does not show a tendency that the science learning experience plays a role in the achievement of students' scientific inquiry skills.

The results of research related to the frequency of conducting experiments / practicum are presented in Figure 2.

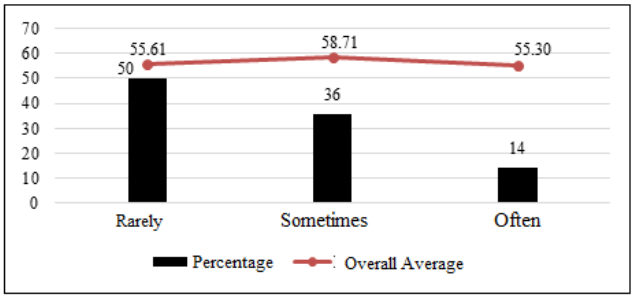


Fig. 2. Frequency of students doing experiments / practicum.

Based on Figure 2, some students admit that they rarely do experiments and practicum. However, based on the achievement map in Figure 2, it appears that the more often students do practicum, this does not increase the achievement of students' scientific inquiry skills.

The results of research related to the independence of students planning and conducting experiments / practicum are presented in Figure 3.

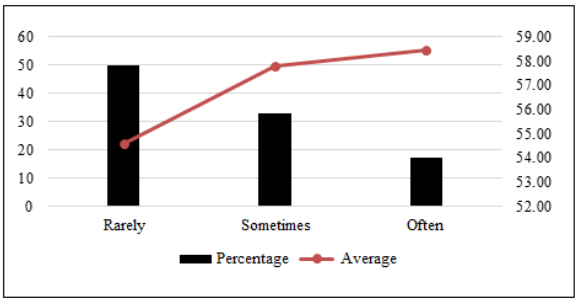


Fig. 3. Students' experiences of planning and conducting independent designed experiments.

Based on Figure 3, it is known that some students rarely plan their own experiments and carry out their own experimental designs. In addition, it appears that independence in planning and carrying out one's own experiments is quite effective in improving students' achievement of scientific inquiry skills.

The following are the results of research related to the frequency and percentage of students to determine their own questions to be investigated in terms of their sub-competencies in students' scientific inquiry skills (Figures 4, 5, 6, and 7).

Figure 4 shows that the achievement of students' scores in the sub competency "differentiating questions that might be scientifically investigated (K.2.2)" is relatively higher than the achievement of students in the sub competency "identifying questions explored in scientific studies (K.2.1)". However, with regard to student learning experiences, some students rarely determine the questions they need to investigate in an experiment. In addition, the data in Figure 4 does not show a tendency that the frequency and percentage of students to determine the questions themselves to be investigated have a role in the achievement of the two sub-competencies in the student's scientific inquiry skills.

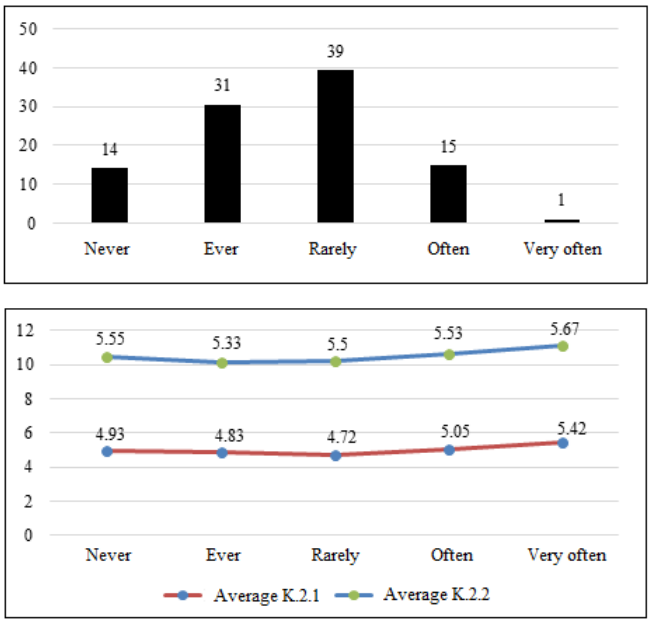


Fig. 4. Frequency and percentage of students to determine their own questions to investigate.

The results of this study indicate that the more often they plan their own practicum, the student's achievement does not increase (Figure 5). Based on the data in Figure 5, it appears that there is a tendency that the more often students plan their own experiments and practicum, the higher the achievement of students' scientific inquiry skills, although this does not apply to the sub-competency "proposing how to explore questions scientifically (K.2.3)".

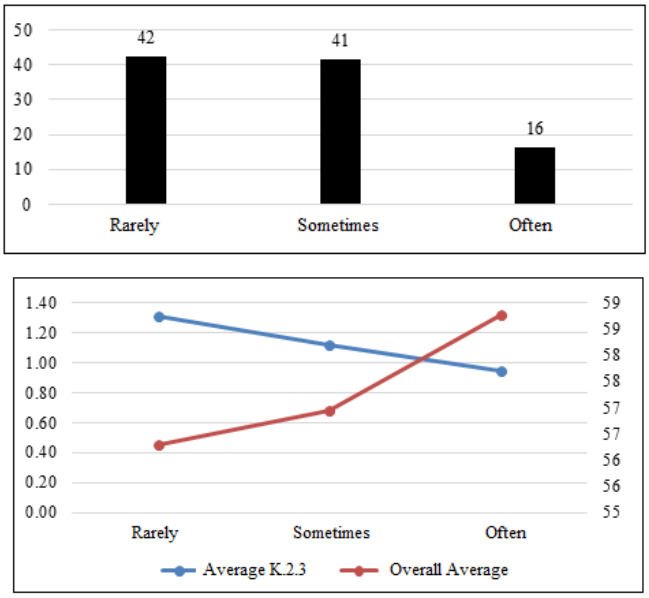


Fig. 5. Frequency and percentage of students planning their own experiments and practicum.

The results of this study indicate that students still rarely repeat the experiments they do, even though based on the data, the more often students repeat the experiment, it can have an effect on effectively improving the achievement of their scientific inquiry skills, especially in the sub competency "explaining and evaluating the reliability of data, objectivity, and research generalizations (K.2.5.) (Figure 6).

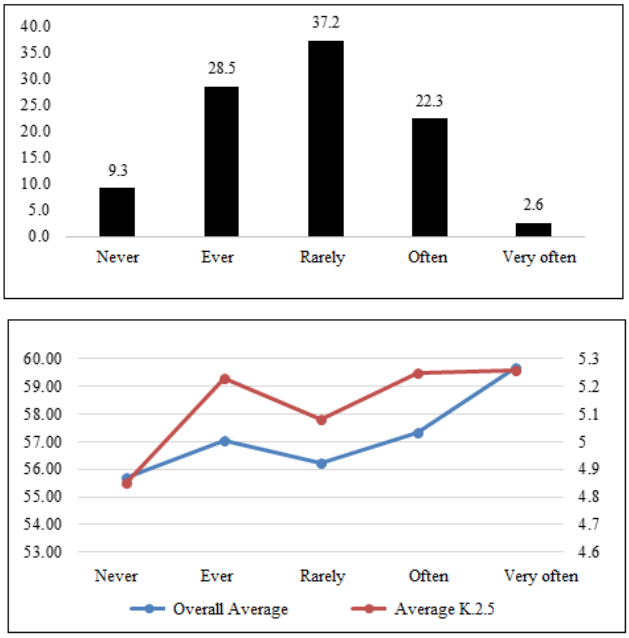


Fig. 6. Frequency and percentage of repeat experiments.

The results of this study indicate that there is a tendency that the independence of students doing experiments / science

practicum plays a role in the achievement of students in the sub-competency "proposing ways to explore scientific questions (K.2.3)".

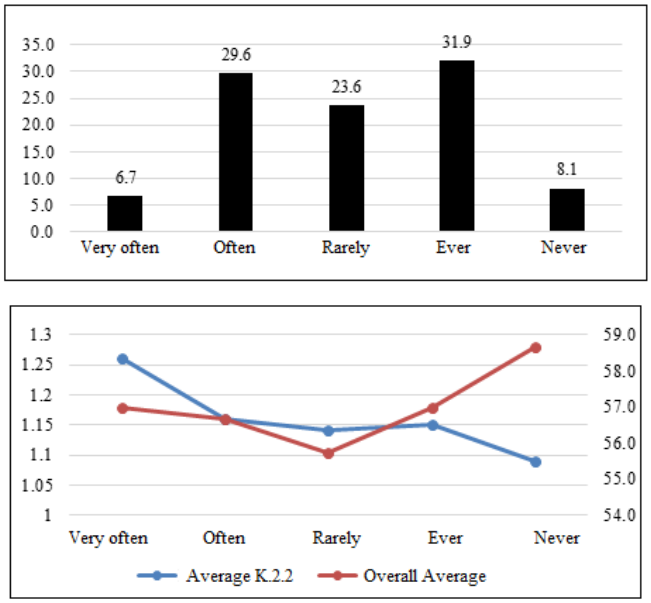


Fig. 7. Student independence in preparing practicum steps.

Based on Figure 7, it appears that the distribution of students' answers is in the choice, often to ever. This means that teachers tend to provide very detailed steps for the experiment to be carried out. The results of this study indicate that for questions that measure "how to explore scientific questions" by composing their own experimental steps, it gives an idea that students who are often given the teacher practical steps will have higher scores than students who are independent in preparing experimental steps.

The following results show that students are not used to interpreting data in tables or graphs (Figure 8). However, based on the data, there is no indication that the habit of interpreting data plays a role in the achievement of the two sub-competencies "interpreting data in tables or graphs (K.3.1)".

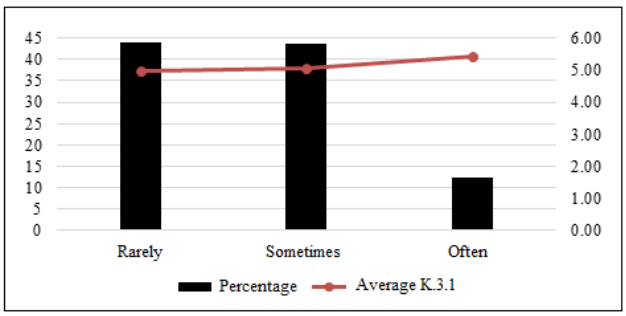


Fig. 8. Students' habits of interpreting data in tables and graphs.

The following results show that the correlation between the habit of designing and making tables / graphs by themselves and the sub-competency of "changing data from one representation to another (K.3.1)" is very low (Figure 9). Even though it is based on data, there is a tendency that the less students design and make their own tables / graphs, the better the skills to change data from one representation to another.

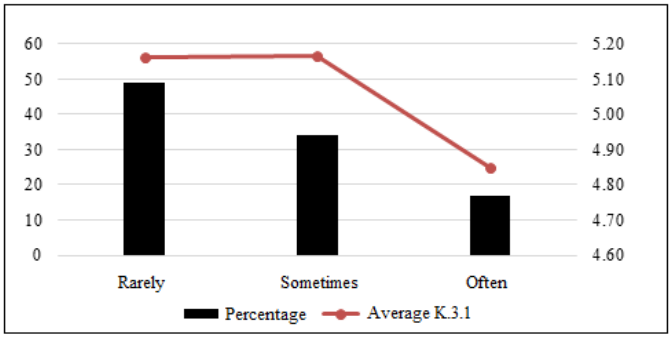


Fig. 9. The habit of designing and making own tables / graphs in practicum.

The results of this study indicate that in general students often evaluate the suitability of experimental procedures with the steps and tools used (Figure 10). Although, based on the data, it does not show a tendency that the habit of evaluating the suitability of experimental procedures with the steps and tools used plays a role in the achievement of students' scientific inquiry skills.

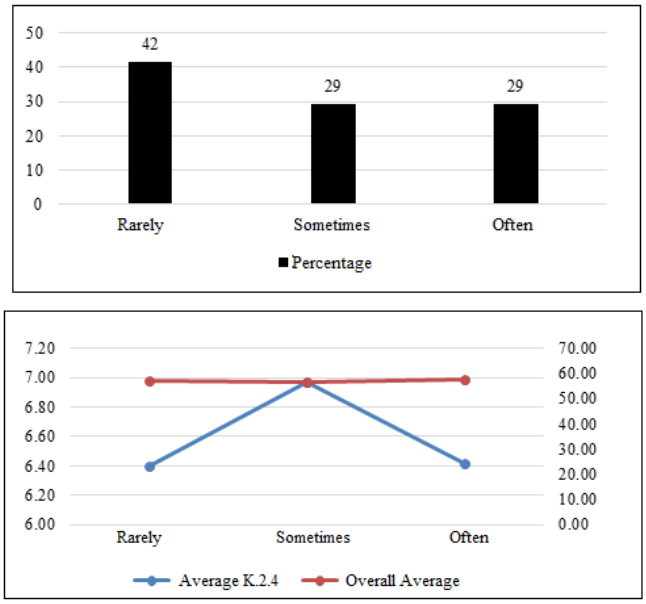


Fig. 10. Percentage of habits evaluating the suitability of the experimental procedure with the steps and tools used.

The results showed that students rarely assessed the suitability of objectives and procedures and the results obtained (Figure 11). The results of this study indicate that the habit of assessing the suitability of goals, procedures with results and

conclusions does not increase student competency achievement. This applies to the relevant sub-competencies and to the overall score.

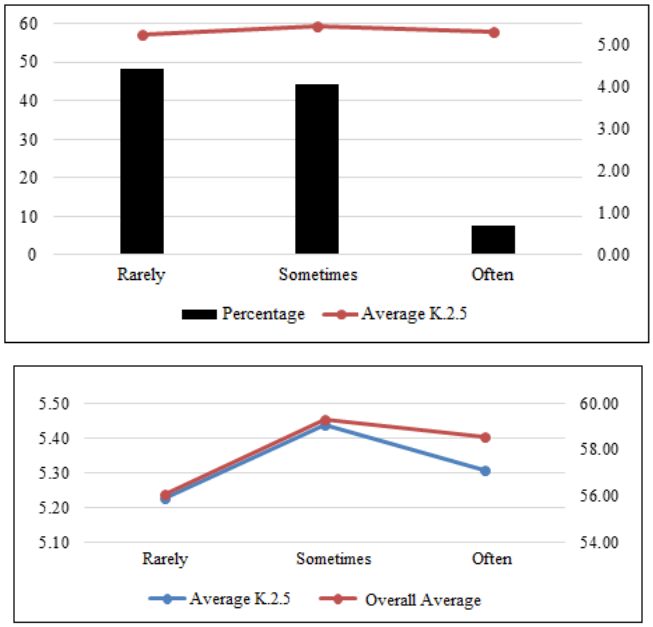


Fig. 11. Habits of assessing the appropriateness of objectives and procedures with results compared to performance scores.

The following results show that some students often assess the accuracy of the experimental procedure (Figure 12). Although, based on the data, it does not show a tendency that the habit of assessing the accuracy of experimental procedures plays a role in the achievement of students' scientific inquiry skills.

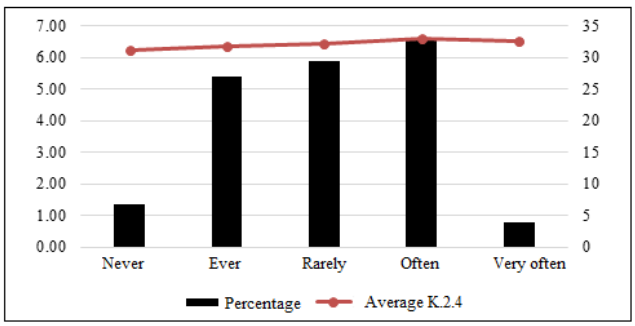


Fig. 12. Habits of assessing accurate experimental procedures related to student competencies.

The results of the research that have been presented indicate that the learning experience of students in learning science has not been maximal and students' scientific inquiry skills need to be improved.

## IV. Discussion

Based on the exposure to the research results, several important facts from the aspects of the learning experience that are thought to play a role in the formation of students' scientific inquiry skills will be presented. When viewed from the facilities owned by students, most students (73.62%) have at-home investigation tools, for example in the form of a thermometer, loop, balance, microscope, and veterinary surgical instruments, and generally have at least one learning resource (science textbooks, scientific books, encyclopedias, and science dictionaries). However, the average scores for the achievement of students' scientific inquiry skills did not show such a large difference.

Some students (51.08%) stated that it was not fun learning science in SD and SMP. Science learning which tends to be textual, not contextual, and often does not emphasize the importance of understanding the nature of science, and low motivation to learn Science is the factors that contribute to the low achievement of science learning outcomes, especially scientific inquiry skills which are an important part of scientific literacy [17,18].

A similar thing was reported by Shirazi, that students in SMP (aged 11-14) were more likely to consider boring science learning and uninspiring science curricular content as the reason for their negative experiences about science in school [20]. Many students made general comments, such as 'science is boring' and 'I don't enjoy science', making it difficult to understand exactly what influenced their dissatisfaction. However, some students attempted to explain their responses by mentioning that they did not like certain science topics or that what they learned in school was not related to 'real' science.

The results of the study also showed that more than half (56.64%) rarely carried out practicum in schools, and most of the students (75.42%) rarely planned and carried out scientific experiments or investigations independently. The results also showed that the more often students plan their own experiments and practicum, the higher the achievement of students' scientific inquiry skills. In addition, it is also known that the independence of students in experimental activities and science practicum is low, such as not being involved in compiling work steps and making tables / graphs of experimental results because the procedure and format for recording experimental results have been prepared by the teacher. This is in line with the results of research by Shirazi, which states that a negative experience related to a very important aspect of school science is a lack of experience in science experiments [20]. The lack of interesting experiments in SMP makes students feel that science, especially theory, has to be learned just to pass an exam. This indicates that students' skills in predicting, observing, describing, explaining, discussing natural phenomena, evaluating the quality of information according to the source, and communicating experimental results still need to be developed.

The research that has been done tries to describe the profile of the learning experience and scientific inquiry skills of students in science subjects in Indonesia. The results of this study can be used as reflection material for teachers in

improving the science learning process. Teachers are expected to be able to integrate scientific inquiry skills in science learning explicitly, so that the implementation of science as a product and process is truly realized. In addition, teachers also need to pay attention to aspects of student interest and motivation in learning science, so as to minimize intrinsic and extrinsic barriers to learning science. These two things are considered crucial to revive student achievement and the quality of science learning in Indonesia.

## V. CONCLUSIONS AND RECOMMENDATIONS

The average score of the students' scientific inquiry skills test was 56.42 or classified as "sufficient". In addition, students' learning experiences in science learning have not been maximized, among others, from the aspect of student involvement in preparing experimental procedures, taking notes, interpreting, and evaluating experimental data.

There are also recommendations for further research in order to obtain more reliable and comprehensive results, it is necessary to expand the scope of respondents, not only from students, but also involving teachers. In addition, it is also necessary to use interviews in order to reveal other facts about students' science learning experiences. In connection with data analysis techniques, statistical analysis can be carried out in order to get a more valid picture of the research results obtained.

## THANK-YOU NOTE

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