Laboratory activity-based learning to improve generic science skills on the concept of sensory systems

A Hayati\textsuperscript{1}, N Juanengsih\textsuperscript{1*}, and D R Fadlilah\textsuperscript{1*}

\textsuperscript{1}Department of Biology Education, Universitas Islam Negeri Syarif Hidayatullah
Jakarta Indonesia

E-mail: nengsih.juanengsih@uinjkt.ac.id, dina.rahma@uinjkt.ac.id

Abstract. According to the previous research, generic science skills are part of 21\textsuperscript{st} century skills. It contributes to individuals' practical and successful participation in the surrounding environment. Therefore, students supposed to be prepared to have generic science skills. These can be trained or honed through learning process that solves the problems. However, based on pre-observation, the reality was different. The teacher plays a role as a providers of knowledge, thus the students are not trained through solve the problem. Practicum is one of learning method/process that contains generic aspects. Practicum is frequently conducted in the laboratory. Thus, this study aims to improve generic science skills through laboratory activity-based learning on the concept of sensory systems. The research method was quasi-experimental with a non-equivalent control group design. The sample consisted of 71 students in the two experimental and control groups. Generic science skills include direct observation, indirect observation, causality, modelling, logical inference, and abstraction. Research instruments using essay tests and observation sheets. The results showed that there was an effect of laboratory activity-based learning on generic science skills. Students' generic science skills in the experimental group were better than the control, particularly in direct observation aspect as well as causality, modelling and logical inference.

1. Introduction

Learning is the process of interaction between students and educators and learning resources in a learning environment [1]. Learning is a concerted attempt to understand events or events to promote learners' learning goals [2]. Informal education learning is a task that is borne by the teacher because teachers are professionals who are prepared for it. Learning activities carried out by each teacher always start from and lead to the learning components that are stated in the curriculum. This statement is based on the fact that teachers' learning activities are a significant part of formal education whose absoluterequirement is a curriculum as a guide. Thus, teachers in designing learning programs and implementing the learning process will always be guided by the curriculum [3].

The curriculum that is currently developing in Indonesia is curriculum 2013. The learning process in the 2013 curriculum is student-centered. The 2013 curriculum with a scientific approach requires studentsto take an active role in the learning process and gain their abilities. The teacher's task, in this case, is as a facilitator, motivator, and mediator.

New standards are needed so that students will have the competencies required in the 21st century. Schools are challenged to find ways to enable students to succeed in work and life by mastering creative thinking skills, flexible problem solving, collaboration, and innovation. Hafiz et al. compared
generic science skills with 21st-century skills. As a result, generic science skills are similar to or part of 21st-century skills [4]. The new generic skills agenda for the 21st century is about life skills as essential as corporate skills and employability [5].

Generic skills are defined as intellectual capability of combination or complex interaction between knowledge and skills [6]. Furthermore, generic skills used in many different fields [5]. Generic skills are a fundamental skill that is general and can be developed when students undergo the learning process as provisions for pursuing a career in the future [7]. Generic skills play an essential role in contributing to individuals' practical and successful participation in the surrounding environment [8]. In addition, generic skills of students could be developed through learning processes that solve the problems [9].

However, when our college student (Department of Biology Education) practiced at SMA Negeri 11 Tangerang Selatan, we observed that the students are less active in the learning process. It also conveyed during an interview with a biology teacher at SMA Negeri 11 Tangerang Selatan that students are less active in implementing learning biology in the classroom. Besides, the result of our observation also has shown that the teacher play a role as a provider of knowledge, thus the students are not trained to discover the knowledge and construct their own concepts. Accordingly, it indicate that Biology learning activities at SMA Negeri 11 Tangerang Selatan was not based on problem-solving learning process. It still do not facilitate students to develop thinking skills and generic science skills to impact the quality of learning the students.

Lack of conceptual authority causes student cognitive learning outcomes below. Low student cognitive learning outcomes cause generic science skills to down as well. According to Liliasari, generic science skills continue to develop along with the increase in higher-order thinking skills; generic science and creative skills are included so that generic science skills can be seen as related to student cognitive learning outcomes [10].

Biology essentially consists of products and processes. Learning biology in both schools and universities not enough with theory alone but requires practicum [11]. Practicum contains generic aspects [12]. Practicum is an ideal vehicle for developing generic abilities. Many generic skills can be acquired through practicum, such as making titles, determining independent and dependent variables, defining problems, making problem questions, and making hypotheses for practicum [11].

Practical-based biology learning can generate the generic science skills of students. Research conducted by Taufik Rahman et al. shows that generic skill-based practicum learning can significantly increase generic science skills [12]. Generic science skills will develop with practice-based learning because students can also apply their theories to practical activities, apart from the knowledge that students gain from the biology learning process to see how far their expertise is at that time. It is also hoped that this will ultimately improve the generic science skills of students.

Students are provided with observation, indirect observation, cause and effect, logical inference, and generic science skills modeling. The results of direct observation documentation are processed and presented in the impact and debate report. They create by inferring themselves as a comparison for further learning.

We see the importance of generic skills in planning science practicum and practicum activities as part of biology subjects near related and mutually determining. The purpose of this study is to assess biology learning based on laboratory activities on generic science skills of students with the sensory system subconcept in SMA Negeri 11 Tangerang South.

2. Method
The method used in this research is a quasi-experiment with Nonequivalent Control Group Design [13]. Based on random technique sampling of population, the sample in this study were 35 students of class XI IPA 1 as the experimental group and 36 students of class XI IPA 2 as the control group. The research was conducted at SMA Negeri 11 Tangerang Selatan in the even semester of the 2018/2019 academic year.
The research uses two kinds of instrument, test and non test (observation sheets). Test instrumen is in the form of description questions to measure students' generic science skills, which have been tested for validity and reliability. The 20 item description questions cover six aspects of students' generic science skills, including direct observation, indirect observation, cause and effect, modeling, inference, and abstract. The test was given to students at the beginning before treatment (pre test) and at the end after treatment (post test). The treatment was Laboratory Activity-Based Learning (Practicum) in two meetings. This study's observation sheet was to see the aspects of generic science skills, direct observation, and students' indirect observation.

The results of processing and data analysis were carried out statistically. As a requirement for hypothesis testing, testing the assumptions of normal distribution using Kolmogorov-Smirnov test and homogeneity using Levene's Test was carried out, followed by hypothesis itself, which is a non-parametric difference test using Mann Whitney test. To know the percentage calculates the percentage of achievement of generic science skills based on the results of observations.

3. Result and Discussion
Pretest and Posttest Data on Generic Science Skills
The results of the pretest and posttest tests in the experimental and control groups can be seen in Table 1.

Table 1. Results of Science Generic Skills Experiment and Control Class.

| Value                  | Pretest | Hypothesis test | Posttest | Hypothesis test |
|------------------------|---------|-----------------|----------|-----------------|
|                        | Experiment | Control |         | Experiment | Control |         |
| Number of Students     | 35       | 36              | Sig/pvalue: | 35       | 36       | Sig/pvalue: |
| Highest Score          | 59       | 64              | α: 0.05 | 90       | 81       |
| Lowest Score           | 27       | 22              |         | 49       | 39       | α: 0.05 |
| Average                | 47.89    | 44.49           | 76.22    | 67.18    |
| Standard Deviation     | 8.05     | 12.35           | conclusion: | 9.53     | 11.62    | conclusion: |

The pretest result data based on table 1 shows that the group experiments have a higher average value than controls. The experimental group had an average value of 47.89, while the control group had an average value of 44.49. After a different test was performed with the Mann Whitney test, the results were 0.168 > 0.05 (α = 0.05), indicating no significant difference between the experimental and control groups.

The posttest results show that the experimental group has a higher average score than the control. The experimental group had an average value of 76.22, while the control group had an average value of 67.18. After a different test with the Mann Whitney test, 0.000 > 0.05 (α = 0.05). These data indicate that there is a significant difference between the experimental and control groups.
Table 2. Results of aspects of generic science skills experiment and control group.

| GSS aspect         | Pretest Experiment | Pretest Control | Hypothesis test | Postest Experiment | Postest Control | Hypothesis test |
|--------------------|-------------------|-----------------|----------------|-------------------|----------------|----------------|
| Direct observation | 67.30             | 66.20           | Sig: 0.912     | 94.44             | 87.65          | Sig: 0.039     |
|                    |                   |                 | α: 0.05        |                   |                 | α: 0.05        |
|                    |                   |                 | conc: 0.912>0.05 |                 |                 | conc: 0.039>0.05 |
|                    |                   |                 | (no significant difference) |                 |                 | (there is significant difference) |
| Indirect observation | 59.04             | 58.79           | Sig: 0.465     | 72.38             | 67.12          | Sig: 0.442     |
|                    |                   |                 | α: 0.05        |                   |                 | α: 0.05        |
|                    |                   |                 | conc: 0.465>0.05 |                 |                 | conc: 0.442>0.05 |
|                    |                   |                 | (no significant difference) |                 |                 | (no significant difference) |
| Cause and effect   | 28.57             | 22.22           | Sig: 0.199     | 64.28             | 40.27          | Sig: 0.026     |
|                    |                   |                 | α: 0.05        |                   |                 | α: 0.05        |
|                    |                   |                 | conc: 0.199>0.05 |                 |                 | conc: 0.026>0.05 |
|                    |                   |                 | (no significant difference) |                 |                 | (there is significant difference) |
| Modelling          | 24.61             | 22.22           | Sig: 0.488     | 55.61             | 43.80          | Sig: 0.014     |
|                    |                   |                 | α: 0.05        |                   |                 | α: 0.05        |
|                    |                   |                 | conc: 0.488>0.05 |                 |                 | conc: 0.014>0.05 |
|                    |                   |                 | (no significant difference) |                 |                 | (there is significant difference) |
| Inference          | 39.38             | 25.51           | Sig: 0.438     | 73.87             | 62.30          | Sig: 0.023     |
|                    |                   |                 | α: 0.05        |                   |                 | α: 0.05        |
|                    |                   |                 | conc: 0.438>0.05 |                 |                 | conc: 0.023>0.05 |
|                    |                   |                 | (no significant difference) |                 |                 | (there is significant difference) |
| Abstraction        | 55.23             | 41.66           | Sig: 0.052     | 79.52             | 76.85          | Sig: 0.875     |
|                    |                   |                 | α: 0.05        |                   |                 | α: 0.05        |
|                    |                   |                 | conc: 0.052>0.05 |                 |                 | conc: 0.875>0.05 |
|                    |                   |                 | (no significant difference) |                 |                 | (there is significant difference) |
| Average            | 45.69             | 41.10           |                | 73.35             | 63.00          |                |

Data in Table 2 shows that the average posttest results of generic science skills in the experimental and control groups are included in good criteria. Based on different tests with Mann Whitney, it shows that the pretest value of the six aspects of generic science skills has a Sig>0.05. These results indicate no significant difference between the experimental and control groups before being given treatment. So it can be concluded that the experimental and control class students have the same initial ability in the six aspects of generic science skills.

The posttest scores in Table 2 for the generic science skills aspect have different values after being given treatment. The result of the statistical test with Mann Whitney showed that the aspect of direct
observation, cause and effect, modeling, and inference had a probability of <0.05. It concluded that there were significant differences between the experimental and control group students on these four aspects after being treated. The indirect observation and abstraction aspects have a probability of >0.05, so it can be concluded that there is no difference between the experimental and control groups in these two aspects after being treated.

Posttest data from the experimental class's generic skills aspect and the control class showed a significant difference in values after being given treatment. Direct observation, cause and effect, modeling, and inference from the experimental and control groups show almost different figures. Only the indirect and abstract aspects of observation did not show a significant difference. After testing the hypothesis on these six aspects, the four elements of generic science skills, namely direct observation, cause and effect, modeling, and inference, show significant differences between the experimental class and the control class in these four aspects. While the other two aspects, namely, indirect and abstract observations, show no significant difference between the experimental and the control group on both aspects.

Observation of Generic Science Skills is carried out during the learning process. Observers observe students. The things that are assessed on the aspects of generic science skills observed during the implementation of practicum learning are direct observation and indirect observation. The data on the average percentage of achievement of the observation of generic science skills in meeting one and meeting two are presented in Table 3.

| Generic Science Skills aspect | Achievement of generic science skills |
|------------------------------|--------------------------------------|
|                              | Experiment | Criteria | Control | Criteria |
| Direct observation           | 95.25      | Very good | 87.50   | Very good |
| Indirect observation         | 91.50      | Very good | 78.75   | Good     |
| Average                      | 93.73      | Very good | 83.12   | Very good |

Table 3 shows that the average percentage of achievement generic science skills for direct observation and indirect observation in both the experimental and control groups are in excellent criteria. After applying laboratory activity-based learning (practicum method) in the experimental group and demonstration method in the control group, there was a significant difference in the posttest results. It indicated that laboratory activity-based learning (practicum) was effectively used to improve students' generic science skills. In line with the theory that a practicum is a form of teaching that is considered quite useful in the classroom, it can cover three domains simultaneously: the cognitive, affective, and psychomotor domains [14]. The third domain can improve students' generic skills, namely communication and written skills, problem skills, math and numeracy skills such as error analysis and estimation, information skills, and interpersonal skills to measure with others. In teamwork and planning abilities [5].

The difference in generic science skills between the experimental and control groups can be seen from the posttest data for four of the six aspects of generic science skills measured in this study: direct observation, cause and effect, modeling, and inference in both classes. The direct observation aspect has a significant difference in value between the experimental and control groups. All students in the experimental group who use laboratory activity-based learning (practicum method) make direct observations on objects so that the data obtained when experimenting is from the results of observations through their respective senses. Whereas in the control class, which uses the method demonstration, not all students experiment. According to Sudarmin, direct observation observes objects directly through the five senses [7]. Like the direct observation aspect, the causal element also has a significant difference in value between the experimental and control classes. The aspect of cause and effect arises because of the belief that natural phenomena are related to one another in a
causal pattern, consequences that can be understood by reasoning [7]. The ability to reason is inseparable from the ability to think critically. A person cannot possibly think critically in a particular field without knowledge of that field's content and theory [15].

The experimental class was directly involved in observation activities. Overall, the experimental group knows more about the phenomena cause and effect during the experiment than the control class. Unlike the causal aspect, the modeling aspect also has a significant difference in scores between the experimental and the control groups. In the modeling aspect, the experimental group directly experimented with the sense of smell to better understand the mechanism of action of the sense of smell, made in an arrow chart. Modeling is imitation, a simplification of what is hoped to help understand it well [7]. Based on the posttest results, it was proven that the experimental class better understood the mechanism of the sense of smell. The results of logical inference can be verified through experiments.

Logic inference skills can be trained through concluding thinking activities based on the data provided [7]. It reinforces that the experimental group using the practicum method has a higher inference value than the control using the demonstration method. In the indirect observation aspect, the experimental and control groups did not show a significant difference. In the indirect observation aspect, students are required to use measuring instruments as a sensory aid in observing experiments. In contrast, students are not used to doing practicum activities at school, so that it can be seen that they have almost the same indirect observation skills. Unlike the indirect observation aspect, the abstraction aspect did not show a significant difference between the experimental and control groups. Abstraction is the ability of students to describe abstract things into simple forms. In general, abstraction is challenging to teach, but some concrete examples experienced in everyday life can be cited to help the abstraction process [7]. Abstraction skills can be improved through a contextual approach. A learning approach begins by taking, simulating, telling, having a dialogue, asking and answering, or discussing real-world events in everyday life experienced by students, then lifted into concepts to be studied and debated [15].

According to Brotosiswoyo, generic skills for direct and indirect observation are in the category of easy to master because the observation process occurs through the five senses (sight, smell, touch, taste, and sensing) [16]. In modeling and cause and effect, these are Generic Science Skills, which are quite challenging to develop, and practicum methods are deemed insufficient to improve both aspects. This result is in line with Rahman's research that cause and effect is a generic ability whose value can be achieved in the low category [12]. Students must change data tables into descriptions and transform word descriptions into graphs or charts in the modeling aspect. In his research, Hartono said that the modeling ability is a complex capability. To create models, the ability to observe, inference, identify, formulate, test, and modify hypotheses is required [17]. Students must explain, link, or determine treatment and treatment results in the aspect of cause and effect.

Practicum is an ideal vehicle for developing generic skills in planning, implementation, and reporting. The practicum's first goal is to develop specific skills such as observing, measuring, interpreting data, and using tools [18]. It is felt that these skills can develop generic science skills in the aspects of direct observation, indirect observation, and modeling. In the direct observation aspect, the activities carried out observe objects using as many senses as possible. Students must use measuring instruments as a sensory aid in observing natural phenomena in the indirect observation aspect. Students must change the data table into the form description (interpret data). Thus, practicum has objectives that are in line with indicators on aspects of generic science skills.

Besides, another goal of the practicum is to improve understanding of the subject matter. This goal reflects the need for practicum activities to increase awareness and broaden students' knowledge (facts, concepts, principles). This contribution can only be realized if practicum activities allow students to perceive natural phenomena with all their senses (touch, sight, taste, listener, and smell) [18]. The learning process in the control class in this study is using the demonstration method. The demonstration method is a teaching method by demonstrating or showing a process [19].
drawback of the demonstration method is that it is difficult for teachers to control indifferent or passive students because they are busy demonstrating the tools [19].

Moreover, if they were not doing activities where students can experiment with personalizing the exercise experience, demonstrations become less successful [20]. In the process, not all students participate actively in experimenting, so that they do not gain practical experiences to develop generic science skills.

4. Conclusion
Research and data analysis showed that laboratory activity-based biology learning affected students' generic science skills in the sensory system sub-concept, especially in the aspects of direct observation, cause and effect, modeling, and inference. To improve generic science skills, problem-based learning are needed, as well as practicum with laboratory-activity learning. Thus, students may create their own concepts in learning. Based on the research results, it is recommended for biology teachers to conduct laboratory-based learning, namely practicum to improve generic science skills.

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