Analysis of pre-service biology teachers’ metacognitive skills on invertebrate zoology

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Abstract. This study aims at obtaining pre-service biology teachers’ metacognitive skills in invertebrate zoology. A number of pre-service biology teachers that take invertebrate zoology course at a state university in Sumatera, Indonesia, were involved as participants in this study. Data on metacognitive skills were collected using metacognitive skills instrument test that have been developed. The data obtained were processed by calculating the percentage (%) for each indicator of metacognitive skills. Results show that the value of pre-service biology teachers’ metacognitive skills on invertebrate zoology are 4.86. For each indicator of metacognitive skill composition were no logic, no systemic, no analyse/evaluate/create (64.56%); no logic, no systemic, less analyse/evaluate/create (31.60%); no logic, no systemic, have analyse/evaluate/create (2.53%), and no logic, have systemic, have analyse/evaluate/create (1.27%). Based on the results of this study, it is suggested that pre-service biology teachers’ metacognitive skills in invertebrate zoology was very low. In order to repair pre-service biology teachers’ metacognitive skills, it is needed revision on instructional strategies for invertebrate zoology course.

1. Introduction
The era of the industrial revolution 4.0 have changed the habits and life in various aspects of society such as health, finance, mobility, infrastructure, and others. Life in such a large amount of information from sensors in physical space accumulates in cyberspace. Big data in cyberspace was analysed by artificial intelligence (AI) and the results of the analysis will back to humans in physical space in various forms [1]. Children currently attending school are future owners of the construction of society 5.0, which is full of turmoil, uncertainty, complexity, and unpredictability. In the world economic forum ten capabilities were formulated to face the super smart society (society 5.0) [2]. The three highest abilities needed were the ability to solve complex problems, critically thinking, and be creative. The development of the three main abilities needed by the future was the responsibility of the education world.

The Indonesian National Qualification Framework (INQF) in the field of higher education was a qualification grading framework that can juxtapose, equalize, and integrate learning achievements from the path of non-formal education, informal education, and / or work experience into the types and levels of higher education. These learning outcomes were abilities obtained through internalization of knowledge, attitudes, skills, competencies, and accumulation of work experience. Therefore, educational institutions must make graduates who have the skills to be used in their lives.

In line with the application of the INQF, the Biology Education Study Program of the Teaching and Education Faculty of Sriwijaya University as an educational institution had learning outcomes including
Able to apply mastery of biological concepts and educational science by utilizing science and technology, (2) Able to apply specific pedagogy to teach the concept of Biology by considering the characteristics of appropriate concepts and pedagogies as the implementation of technological pedagogical content knowledge (TPCK), (3) Mastering work skills and managerial skills in managing school laboratories by utilizing the development of science and technology, (4) Having morals, ethics, good responsibility, personality and independence in completing the task as a Biology educator. The learning achievements show that the Biology Education Study Program of teaching and training faculty of Sriwijaya University had the aim of forming graduates who were competent in their fields, both cognitive, affective, and psychomotor. In order to achieve this goal, Biology Education Study Program directs the learning achievements in a number of courses, including Invertebrate Zoology.

Invertebrate Zoology is a science of the animal world that does not have a backbone associated with taxonomy and life. Based on the concepts learned in invertebrate zoology, this course requires students to be able to understand, analyse, link and compare the characteristics of an animal so that it supports the taxonomy of the animal. Based on syllabus and Course Program Plans (RPP) analysing of the course, generally lectures were carried out using varied lecture methods. This teacher-centered learning process results in underdeveloped student thinking skills. Final exam results of invertebrate zoology in biology education students in Sriwijaya University showed an average of 60 (low). Students were forced to take part in learning which results in the lack of independence, mastery of concepts, attitudes, and morals [3,4]. This learning process also occurs in other tertiary institutions.

Learning whose information is dominated by lecturers, and lack of training in students' thinking skills (metacognition) takes place in the Biology Education Department of the Ganesha University of Education and Muhammadyah University of Malang [5,6]. Less effective lecture time for a very broad range of material is a lecture problem in the Department of Biology, Faculty of Mathematics and Natural Sciences, State University of Makassar [7], students are not interested in finding other sources of information on the Biology Education Study Program (FKIP) Budi Utomo Malang [8]. The low end of the semester exam results were thought out by students have not been trained or skilled in using their cognitive (thinking about thinking).

These thinking about thinking skills in the world of education are called metacognitive skills. In learning, metacognitive skills play a role in the ability to analyse, complete tasks, monitor, care, make decisions, improve performance [9-12]. Metacognitive skills have a significant relationship with academic achievement, critical thinking skills, and scientific attitudes of students [13-16]. Empowerment of metacognitive skills requires process and time because everyone is different to realize and regulate their cognitive. Good metacognitive skills can provide good results for one's learning as obtained in research [17].

Based on the results of the semester exams in zoology invertebrate lectures are low and it is suspected because of the low metacognitive skills of students. Therefore, a survey was conducted to prove this suspicion by describing the metacognitive skills of Biology Education Study Program students at the University of Sriwijaya in the invertebrate zoology course. The statement of problem in this research was how the profile of pre-service biology teachers’ metacognitive skills on zoology invertebrate course. This study aims to obtaining the value and position of metacognitive skills indicators of pre-service biology teachers on zoology invertebrate course. The results of this study are expected to provide information on the metacognitive skills profile of pre-service biology teachers that a revision on instructional to develop their metacognition.

2. Methods

2.1. Types and research samples
This research is a descriptive study with survey method. The study was conducted in August 2019 by distributing metacognitive skills assessment instruments to the research sample. The sample in this study were pre-service biology teachers attending the Invertebrate Zoology course 2019-2020 academic year.
in the Biology Education Study Program at Sriwijaya University, Indonesia. The research sample included 79 students consisting of 74 women and 5 men.

2.2. Research instruments

The instrument used in this study was an instrument for measuring metacognitive skills, namely item achievement tests (metacognitive skills integrated with cognitive) and rubric scoring of metacognitive skills. Achievement test items made in the form of essay question items containing levels of thinking based on Bloom's revised taxonomy of 5 questions. The distribution of questions is based on lecture topics, for example Protozoa, porifera, and coelenterate. The questions made have a cognitive level of remembering (C1) to Synthesis (C6). The metacognitive skills question was integrated into the cognitive of three items consisting of the achievement of analytical competence (C4), evaluation (C5), and creation (C6). This item which has analytical thinking, evaluation, and creation level contains metacognitive skill indicators, such as logical, systematic, analysis / evaluation / creation. Metacognitive skills assessment used the developed metacognitive skills assessment rubric [18].

2.3. Research procedures

This research was carried out through several stages, namely preparation, data collection and analysis of research results. In the preparation phase, the researcher developed an achievement test item of 8 questions. After the validation process five item items were obtained. At the data collection stage, the researcher distributes the items to be worked on by the research sample for 100 minutes. The answers obtained are then examined both for cognitive use of the cognitive learning outcomes rubric and raw metacognitive skills using the metacognitive skills assessment rubric as follows:

| Score | Description |
|-------|-------------|
| 7     | The answer is written in their own sentences. The order of answer is harmonious as well as systematic. The answer is logic in correct grammar, supported by explaining reason (analytic, evaluative, or creative explanation), and the answer is correct. |
| 6     | The answer is written in their own sentences. The order of answer is harmonious as well systematic. The answer is logic in less correct grammar, supported by explaining reason (analytic, evaluative, or creative explanation), and the answer is correct. |
| 5     | The answer is written in their own sentences. The order of the answer is less/unharmonious as well as less/unsystematic. The answer is less/ not logic in less correct grammar, supported by explaining reason (analytic, evaluative, or creative explanation), and the answer is correct. |
| 4     | The answer is not written in their own sentences. The order of answer sentences is harmonious as well as systematic. The answer is logic in correct grammar, supported by explaining reason (analytic, evaluative, or creative explanation), and the answer is correct. |
| 3     | The answer is not written in their own sentences. The order of answer sentences is less/unharmonious as well as less/unsystematic. The answer is less/not logic, in less correct grammar, supported by explaining reason (analytic, evaluative, or creative explanation), and the answer is correct. |
| 2     | The answer is not written in their own sentences. The order of answer sentences is less/unharmonious as well as less/unsystematic. The answer is less/not logic, in less correct grammar, not supported by explaining reason (analytic, evaluative, or creative explanation), and the answer is less correct. |
| 1     | The answer is not written in their own sentences. The order of answer sentences is less/unharmonious as well as less/unsystematic. The answer is less/not logic, in less correct grammar, not supported by explaining reason (analytic, evaluative, or creative explanation), and the answer is not correct. |
| 0     | There is no answer at all. |

Figure 1. Metacognitive skills assessment rubric [18].

The raw scores obtained are then converted to a scale from 0-100. Conversion of raw scores on cognitive learning outcomes using the following formula:

\[
\text{Score} = \frac{\text{total score}}{\text{score maximum}} \times 100
\]  \hspace{1cm} (1)
Converting raw scores of metacognitive skills follows the following formula:

\[ \frac{y_1 + 2x}{3} = y_2 \]  

(2)

Note:
\( x \) : Metacognitive Skill Score
\( y_1 \) : Concept Gaining score
\( y_2 \) : Concept Gaining score combination and raw metacognitive skills score

Data on the value of metacognitive skills obtained after this conversion then as data in this study.

2.4. Data analysis

The data obtained were analysed using descriptive statistics analysis. The statistics used include the mean with the help of the IBM SPSS version 22 program. The mean from each measurement scale is then used to categorize the level of metacognitive skills that refer to the learning outcomes assessment standard set by FKIP Sriwijaya University, which is very low (0-40.99), low (0-40.99) 41-55.99), enough (56-70.99), high (71-85.99), very high (86-100). Furthermore, to see the position of metacognitive skills of students is done by calculating the frequency of answers obtained based on the rubric of metacognitive skills.

3. Results and discussion

A survey on the measurement of metacognitive skills of prospective biology teacher students in Invertebrate Zoology has been carried out on 79 students. The frequency of positions per indicator of metacognitive skills and the value of metacognitive skills were obtained as data on the results of this study. The results of the survey on indicators of metacognitive skills of prospective biology teachers in zoology invertebrate lectures can be seen in Figure 2.

Figure 2. Frequency of metacognitive skills indicator level.

Figure 2 shows that there are several positions of metacognitive skills based on the level of scores found in the rubric of metacognitive skills, as much as 64.56% of pre-service biology teachers were in a state that does not have logic, was not systematic, and had not been able to analyse / evaluate / be creative; 31.65% of pre-service biology teachers were in a condition that does not have logic, was not systematic, and had less analysis / evaluation / creation; 2.53% of pre-service biology teachers were in a condition that had no logic, was not systematic, and had analysis / evaluation / creation; 1.27% were in a state that
had no logic, has been systematic, and was able to analyse / evaluate / be creative. Figure 2 shows that more than 50% of pre-service biology teacher do not have metacognitive skills. The survey results about the value of metacognitive skills of pre-service biology teacher in zoology invertebrate course can be seen in Table 1.

Table 1. The value of metacognitive skills on invertebrate zoology course.

| Metacognitive Skills | N     | Minimum | Maximum | Mean   | Standard Deviation |
|----------------------|-------|---------|---------|--------|--------------------|
| Valid N (Listwise)   | 79    | 0.71    | 22.32   | 4.86   | 4.08               |

Table 1 shows that the average value of pre-service biology teacher metacognitive skills was 4.86. Table 1 shows that the metacognitive skills of pre-service biology teachers are in the very low category. Similar results have also been found in various studies. Previous research show that metacognition of Ganesha University students was low [5]. Research Miharja [6] also states that the metacognitive skills of University of Muhammadiyah Malang’s students were low. The low value of metacognitive skills that occur due to the learning process that does not emphasize the process of metacognition.

Based on the RPP analysis of invertebrate zoology course for the academic year 2018-2019, it appeared that the lecture methods conducted have varied, but the lecture activities do not emphasize the process of developing metacognitive skills. Measurement of ability, achievement, and / or competence cannot be separated from the important role of metacognition in the learning process. The performance of students with high metacognitive skills was better than students with low metacognitive skills [11]. Metacognitive skills can be developed through a process or form of learning that can practice metacognitive regulation. The process of empowering metacognitive skills can be done with strategies, approaches or learning models that demand cognitive regulation activities, namely analysis, evaluation, or creations in them.

In this metacognitive strategy, educators train students' skills in planning and monitoring cognitive activities and evaluating the results of each activity carried out. The metacognitive culture can be trained by the teacher by giving students the opportunity to identify difficulties, find difficulties and acknowledge them, and integrate their reflections into their learning tasks [19].

Some learning models that are active, constructive can be used as metacognitive strategies, namely Problem Based Learning (PBL) which is integrated or integrated with other strategies or models proven to influence and improve metacognition [20-22]. Learning styles and motivation as well as the learning environment in schools and families also need to be considered in empowering metacognition [23,24]. Metacognitive strategies through multi strategy and combined in a learning journal have more potential to improve student learning outcomes [25]. In practicing metacognitive skills, educators as learning facilitators can empower them through metacognitive strategies. In line with the statement that the use of metacognitive strategies can influence the development of metacognitive skills [17].

4. Conclusion
Based on the results of research and discussion it can be concluded that pre-service biology teachers had a very low value of metacognitive skills (4.86) and are in a position of more than 50% do not had logic, have not been systematic, have not been able to analyse / evaluate / creative. It was recommended that zoology invertebrate course change the instructional strategies that had been used so far.

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