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The Analysis of Scientific Argumentation Skill and Computational Thinking Skill of The Primary Educational Teacher Department Students

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Abstract. Scientific argumentation skill is very important to be mastered by students. It allows students to analyze, to make decisions based on the result of thinking, and to apply science in everyday life. This study aims to analyze and describe the characteristics of students' scientific argumentative skills in the Primary Educational Teacher Department based on the results of computational thinking tests about motion system material. This is exploratory research with quantitative and qualitative data analysis to understand the characteristics of students' answers in proposing scientific arguments and computational thinking. The participants of this study were second-year students in class-D of Primary Educational Teacher Department in the even semester of class 2019/2020. They were taken by a random sampling technique. The applied instrument was a written test instrument with a subjective form entailed by indicators of computational thinking skills. This applied instrument was to identify and analyze the characteristics of students' scientific argumentative skills. The results were then analyzed descriptively with Toulmin's Argumentation Pattern (TAP). The results showed that the characteristics of scientific argumentation skill of Primary Educational Teacher Department students were 4% of students at level 1, 8% of students at level 2, 15% of students at level 3, 31% of students at level 4, and 43% of students at level 5. On another hand, the results of computational skills showed that the students' thinking was high in the analyzing stage, elaborating, providing hypotheses, and finding patterns of problems. The results of this analysis indicated that the characteristics of scientific argumentation skills and computational thinking skills of Primary Educational Teacher Department students need to be developed optimally.

INTRODUCTION

Increasing student soft skills is a challenge for Educational Institutions of Educational Personnel. Through the Higher Education process, student soft skills can be honed and cannot be replaced by systems or technological sophistication. In the era of the industrial revolution, 4.0 students were required to master thinking skills, technology, and other skills. Thus, innovative and dynamic efforts to improve the quality of Higher Education are required. Elementary School Teacher Education Students are prospective teachers who must be prepared to have the skills. The skills should be qualified based on the demands of the 21st century so that the next generation of the nation will have that skill if the teacher has qualified skills.

The required skills are critical thinking skills, creative thinking, and problem-solving skills. Besides, those required skills, in the 21st century, the skills should include scientific literacy and computational thinking [1]. One of the manifestations of scientific literacy can be seen from the skill of students' scientific argumentation. Science literacy is closely related to science contents, science contexts, and science competencies. The skill to have scientific argumentation is very important for students. The skill allows students to analyze and make decisions based on the results of thought and implementation of science in everyday life based on scientific literacy. On another hand, computational thinking is a new literacy. It is based on the conditions of the 21st century. It deals with the necessity to integrate various ways of thinking, starting from abstract thinking, logical thinking, modeling thinking, and

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constructive thinking [2]. These challenges are the basis for developing scientific argumentation skills, as well as problem-solving skills. The skill to argue is one of the important skills possessed by students. The skill of scientific argumentation is the process of strengthening a claim by emphasizing the skill to express ideas and ideas about scientific phenomena in everyday life based on evidence and their compatibility with existing theories. Argumentation has an important role in science learning activities. It provides an opportunity for students to engage in group discussions and give each other opinions that demonstrate the skill to understand concepts, skills, and the skill to reason scientifically [3]. The skill to argue scientifically will certainly be supported by relevant information, empirical evidence, and can be verified. Argumentation is an important component in scientific literacy. Therefore, students can master the concepts of science by being able to argue properly [4].

Based on the results of previous studies, [5] the results of the scientific literacy of Primary Educational Teacher Department students obtained a percentage of 66.2%. They were at a nominal level. 33.8% of students were at the functional level. This nominal level showed that students could identify the form of a concept. However, they were unable to understand the concept clearly [6]. It could be clarified that students could understand patterns/ways of thinking. However, the understanding of problems and the application of scientific concepts with scientific arguments following the understanding they received has not been maximized yet. The results of identification [7] showed the argumentation skills of prospective teacher students. The results showed that they were still lacking in arguing due to a lack of concept. Based on these findings, it can be stated that students should always be involved in discussion activities so that they are skilled in arguing and making the right decisions in daily life. By their participation in arguing, they learn to appreciate the relationship between evidence and claims and the importance of justification in scientific arguments. From these different perspectives, researchers of the argumentation quality have developed theoretical and methodological frameworks for the conception and analysis of arguments in science [4,8,9]. The measurement of scientific arguments is measured based on Toulmin's Argumentation Pattern (TAP). In TAP, the components of scientific argumentation consist of data, claims, justification (warrant), support (backing), and rebuttal. Data is a phenomenon that is used as evidence to support claims. Claims are the results of established values, opinions about the value of the situation, or affirmation from the point of view. Justification is the rule and principle that explain the relationship between data and claims. Support is the basis of the assumptions underlying certain justifications. A disclaimer is a certain case where claims cannot be verified or there are different arguments [10].

Computational thinking is the skill possessed to solve complex problems by involving ideas, modeling, and promoting simulation as if it was a computer [11]. Computational thinking is very important because not all problems can be solved by just thinking from one perspective. Therefore, it is important to integrate various disciplines by involving technology, modeling, and simulation [2,12,13]. Computational thinking is needed to innovate in science, technology, machinery, and mathematics (STEM) [14]. Computational thinking (CT) is a part of the way of thinking and titrating science as a form of innovation in the implementation of learning science. The characteristics of CT skills are: (1) collecting data logically and analyzing it; (2) modeling the data, abstract, or hypothesis and simulation; (3) formulating the problem, for example with the help of a computer; (4) identifying, testing, and implementing possible solutions; (5) automating, namely choosing the right or incorrect information through algorithmic thinking; and (6) concluding and applying the process to other problems [1,12].

Improvements in science learning in elementary school teacher education study programs have been carried out in Science Concept courses, especially in the system of motion systems (motion in Physics and Biology). One of the obtained results was the development of teaching materials based on scientific literacy. It was to develop computational thinking skills with the results of effectiveness tests showing that the skill of CT students taught by science literacy-based science concept teaching materials was higher than the CT skills of students taught without teaching materials based on the scientific concept of scientific literacy [13]. However, from these data, the quality of scientific argumentation and CT skills of students remained uncertain. For this reason, the researchers conducted this follow-up study with the objectives to analyze and describe the characteristics of students' scientific argumentative skills in the Primary Educational Teacher Department based on the results of the computational thinking tests on the motion system material.

METHOD

This research is exploratory research with quantitative and qualitative data analysis to analyze the characteristics of students' answers in proposing scientific arguments and computational thinking. The data were obtained from the measurement of quantitative argumentation and computational thinking skills. The qualitative data were in the form of analysis of students' answers which were arranged with computational thinking indicators. The participants of this study were the 44-second year students of D class of Primary Educational Teacher Department students in the even semester of class 2019/2020 taken by random sampling technique. The applied instrument was a written test instrument with a subjective form with indicators of computational thinking skills. Indicators of computational thinking skills include; 1) the skill to analyze and find data, ideas, and facts, 2) describe specific data or problems, 3) create abstraction/hypothetical, 4) find patterns of problems, 5) arrange systematic problem-solving algorithms, 6) automate, choose ways appropriate, as well as determining/decision making, 7) simulation of the steps used, and 8) concluding. The applied instruments amounted to 16 representing 8 indicators of computational thinking skills with a proportion of 8 questions about the influence of motion on Newton's objects and laws, while 8 items dealt with the matter of motion systems in low-level living things, motion in high-level living things.

This instrument was used to identify and analyze the characteristics of students' scientific argumentative skills. The results were then analyzed descriptively with Toulmin's Argumentation Pattern (TAP). The argumentation component consists of *claims, evidence, warrant, backing, qualifier*, and *rebuttal* [15]. These components could identify aspects of the arguments to be assessed and could assess the justification of an argument. Components argumentation Toulmin (TAP) is a structural basis of the argument that can improve the skill of argumentation of students both in oral and written. The data was analyzed to measure the quality of the argumentation by Osborne [16]. It was due to the division of the quality of the arguments for each level that was clear and had the characteristics of the answers to the students on the material concept of Science.

RESULT AND DISCUSSION

This research was the first step in solving problems about misconceptions experienced by students. A statement by [17] states that explorative research can be considered as the first step which is expected to be used to formulate problems in which problem-solving might be solved by using other types or types of research. The initial research is descriptive and explanative. This is also consistent with his opinion [18] that the purpose of exploratory research is to produce generalizations derived from inductive processes about the group, process, activity, or situation being studied. CT skills can be improved by prospective teachers through professional learning, including student-centered learning by discovering its concepts [19]. Therefore, this research step was begun by giving a total of 16 essay questions for students. The questions contained indicators of computational thinking. Computational thinking tests were given for the students to measure their CT skills. This research was devoted to the material of the motion system consisting of motion in low-level living things, motion in high-level living things, the effect of motion on the matter, and Newton's laws. TABLE 1 presents the Recapitulation of the results of the analysis of the CT skills of students.

TABLE 1. Recapitulation of Students' CT Skills Analysis Results

No	Concepts	CT Skills Indicators	Average Student Score Acquisition
1	Effect of motion on objects	The skills to analyze and find data, ideas, and facts	84.6
2	The system of motion in low level living things		89.1
3	Effect of motion on objects	Outlining the data or problems are specific	85.2
4	The system of motion in low level living things		83.6
5	Effect of motion on objects	Making abstraction/hypotheses	82.5
6	The system of motion in low level living things		87.7
7	Effect of motion on objects	Find a pattern of problems	86.4
8	The system of motion in low level living things		79.6
9	Newton's Law	Construct algorithms to solve the problem in a systematic	80
10	The system of motion in high level living things		79.6
11	Newton's Law	Perform automation, choose the right way, as well as determine/decision-making	75.7
12	The system of motion in high level living things		73.4
13	Newton's Law	Simulation steps are used	57.3
14	The system of motion in high level living things		71.6
15	Newton's Law	Concluded	47.5
16	The system of motion in high level living things		61.4

From the results of the analysis in TABLE 1 show that students can find solutions, but are not optimal on the indicator algorithm, automating, simulating, and concluding. It could be said that students had not maximized problem-solving systems and their scientific argumentation skills were limited. The research of [20] revealed that students had understood the concept of science but they had not been able to think comprehensively in solving the given problems.

To determine the appropriate skill of the assumptions about scientific arguments, the next step, the data in table 3 is analyzed descriptively with Toulmin's Argumentation Pattern (TAP). The components of scientific argumentation consist of claims, evidence, warrant, backing, qualifier, and rebuttal [15]. The indicators of computational thinking skills also emphasize the skills of scientific argumentation. Thus, it can be linked and developed directly with the learning process that has been carried out by lecturers to support the Science Concept course. Some learning patterns had been carried out with learning activities including practicum, application of teaching materials, and the application of innovative learning models for the development of CT skills and students' scientific argumentation skills. Through practical activities, students had to reason, argue, find concepts, and solve problems. That was caused by the skills of argumentation related to reasoning someone [21]. Therefore, the teacher had to design learning that can express students' argumentative skills. This explanation was made clear by [22] that students had to be involved in activities that required them to argue, think, and justify their arguments. It was stated by [23] that the skill of students' scientific argumentation is very important to be applied during learning activities as a way of eliciting conceptual learning. Furthermore, [24] reinforced the more understanding of the concept, then students could provide a complete and complete argument The skill of arguing in perspective is very important in building an explanation, model, and theory of a learned concept [9]. Tab II shows the results of the analysis of the quality characteristics of students' scientific arguments with the results of CT skills tests.

TABLE 2. Recapitulation of the Results of Analysis of Students' Scientific Argumentation Characteristics

Level	Characteristics	Percentage of student acquisition
Level 5	Complex arguments with more than one rebuttal.	43%
Level 4	Arguments with the *claim* and *rebuttal* were identified with the obvious.	31%
Level 3	Arguments with *claims* or *counterclaims* that are accompanied by data, warrant, or backing and accompanied by a weak rebuttal.	15%
Level 2	The arguments which consisted of claim include the data, warrant, or backing, without rebuttal.	8%
Level 1	Simple arguments in the form of *claims* or *counterclaims*	4%

Based on the findings of the characteristics of scientific arguments in table 4, it could be concluded that students had been able to submit scientific arguments to complex arguments with more rebuttal with various stimulants by lecturers. It was found with a percentage of 43% at level 5 and a percentage of 31% at level 4. These results indicated that students had been able to express their arguments although still weak, unclear, and inaccurate. For this reason, more learning activities would be needed to enhance the skill of students to submit arguments. This opinion is corroborated by the opinion of [25] who revealed that students could achieve the results of science education to the fullest by giving them more opportunities to learn about scientific argumentation. The skill to argue can develop well if students can interpret concepts in the learning process that trains students to reason scientifically and display scientific problems [26]. The skill of scientific argumentation is strongly influenced by the understanding of concepts received by students as a whole unit so that misconceptions or missing concepts do not occur. The statement by [27] reinforces the explanation that scientific argumentation is not based on sufficient conceptual knowledge, it is anticipated that students' arguments will not benefit students in understanding the material. A good argument needs to be based on sufficient conceptual knowledge [21,28]. These findings supported researchers to make improvements for learning to improve students' soft skills, especially in the skill of scientific argumentation and CT skills. Through the process of argumentation, students learn to build their scientific knowledge from data or evidence obtained by themselves and an understanding of scientific phenomena so that they can express it in scientific argumentation with the warrant, based on the support of justification and claims as well as support for claims that have been expressed with support or rebuttal. The results of this study are also supported by other studies. The studies revealed that teaching science, technology, and literacy was very important because this would be a provision for students to understand and master an understanding of science and technology through their literacy skills [29]. From the recapitulation of TABLE 1 and TABLE 2, it could be linked that the scientific argumentation skills and CT skills of students supported each other maximally. This could have happened if students were able to convey automation, simulation and draw conclusions (on the CT indicator) then the student's scientific argumentation skill was at level 5, which was being able to connect claims and support to claims that had been expressed with a rebuttal. In other words, students had been able to convey scientific arguments when their CT skills are good.

CONCLUSION

Based on data analysis and discussion, it could be concluded that the characteristics of the scientific argumentation skill of Primary Educational Teacher Department students were 4% of students at level 1, 8% of students at level 2, 15% of students at level 3, 31% of students at level 4, and 43% of students at level 5. The average results of computational thinking skills were high. They were found in analysis, outlines, giving hypothesis, and finding a pattern of problems, but they were not found in the indicators of algorithms, automation, simulations, and conclusion. It descriptively indicated that the skill of scientific argument and CT skills supported students to support each other if both were maximized. It is suggested for educators to improve student soft skills. The skill of scientific argumentation and CT skills could be obtained optimally through the learning process by involving students actively in finding concepts and arguing so that students can learn to construct scientific knowledge from data or evidence obtained by themselves and by analyzing scientific phenomena that exist in everyday life.

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