Perceptions of prospective chemistry teachers about the skills of writing argument-based teaching material on voltaic cell subject

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Abstract. Teaching materials and scientific argumentation should be provided to prospective chemistry teachers to fulfil their required professional competencies. The study aims to investigate the information about the students’ perceptions concerning the ability in writing argument-based teaching materials for prospective teachers on voltaic cell subject. Twenty-one students of chemistry education program at the fifth semester, who are taking the subject of school chemistry in one university in Bandung, West Java, are chosen as the participants of this study. Questionnaires and interview are employed as the instruments. They are used to investigate the students’ perceptions towards the characteristics of voltaic cell materials. The ability to draw a scientific argumentation (involve claim, data, warrant, backing, qualifier, rebuttal) is revealed through the instruments of teaching materials writing task assessment. This study indicates that most of students’s perception are that prospective chemistry teachers have to be able to write teaching materials and scientific argumentation and voltaic cell materials are easy to comprehend because it is a concrete material. The students have a difficulty to find a topic and to distinguish warrant component, backing, qualifier, rebuttal. Furthermore, the argumentation ability possessed by the students on their teaching materials is still considered in low category.

1. Introduction
Writing teaching materials is one of the skills the teachers must acquire. It is relevant with the demands of teacher professional competence in the Regulation of the Minister of National Education [1]. Writing teaching materials are also relevant with the National Teacher Association (NSTA). Moreover, the related curriculum asserts that a prospective teacher must be able to write and conduct varied teaching materials, which are beneficial in the teaching and learning process, by proposing various sources [2]. Teaching materials should be written and conducted in accordance with the prerequisites of the curriculum and students’ development [3].

Teaching material is a scientific communication between students and teachers concerning the concepts being learned. Therefore, it must be able to deliver the messages to the students in a proper way, accurate, easy to comprehend, able to convert an abstract knowledge into a simple and concrete analogy for the students [4]. Teaching material plays an important role in the teaching and learning
process where it provides students a simple scientific explanation about the material being learned [5]. Scientific explanation is constructed through the clarity of thought, examples and additional information which are able to fill and improve the knowledge gaps. In other words, scientific explanation is developed through proper arguments [6].

Argument is a crucial thing to construct an explanation, model, and theory [7]. Argument is resulted from an argumentation, which is defined as a dialogue between two or more individuals, to connect certain facts and theories into a comprehensive explanation regarding a model, prediction, and evaluation [8]. Acquiring a science argument can be used as a tool to construct a knowledge [9]. The argument, stated by Toulmin, can be defined as a series of claims about a set of data, a warrant to justify a claim, a rebuttal of a claim or warrant. Data are facts that support a claim. Warrant is an inference, which is relevant with the data that supports a claim. Meanwhile, backing provides a support to the warrant. Rebuttal offers an exception of an argument and a qualifier that shows the confidence level given to the claim through warrant [10].

Voltaic cell material is categorized as an abstract concept that provides concrete examples [11] which is considered as one of the difficult materials to learn both by teacher and students [12]. Voltaic cell is considered difficult because it is related to electricity current and redox reaction [13]. Furthermore, students’ misconceptions commonly occur in this material. The common misconceptions are: identifying, anode and cathode along with its functions, explaining how the electricity current occurs inside the voltaic cell and the functions of the salt bridge [14, 15]. To assist students learning voltaic cell and reduce misconceptions requires an argument-based teaching materials that delineates voltaic cell with facts or related phenomena and justifications strengthened by the theories.

The literature related to students’ perception concerning writing teaching materials, argumentation in teaching materials, and the difficulty in writing argument-based teaching materials are still limited. Hence, this study aims to investigate the information regarding the perception of prospective chemistry teacher in writing argument-based teaching materials on voltaic cell material.

2. Method
This case study was conducted in one of universities in Bandung, West Java. Twenty-one students of chemistry education program at the fifth semester, who are taking the subject of school chemistry, were chosen as the respondents.

Questionnaire, interview, and textual writing of teaching materials concerning voltaic cell were employed to gather the students’ information. The information obtained was about the students’ perception on the characteristic of voltaic cell material, the skills of writing teaching materials for prospective teachers, arguments in teaching materials, and the difficulties to conduct argument-based teaching materials.

This case study employed a descriptive-qualitative approach. The data were obtained through questionnaires, interview, and students’ textual teaching material. Questionnaires and interview were used to gather students’ perception concerning the characteristic of voltaic cell material, the skills of writing teaching materials for prospective teachers, arguments in teaching materials, and the difficulties to conduct argument-based teaching materials. Students’ textual teaching materials were employed to obtain the information regarding students’ argumentation skill. Questionnaires and interview were analysed descriptively as a reflection of what happened in the field. On the other hand, students’ textual teaching materials were analysed by using modified Toulmin’s Argumentation Pattern (TAP) Scheme [16].

3. Result and discussion
3.1. Students’ perception concerning the writing of teaching materials for prospective teachers
This study indicates that students as prospective teachers state that a prospective teacher should possess an ability to write a teaching material. In other words, prospective teachers who possesses an ability to write teaching materials has fulfilled their teacher professional competence standards which are relevant
with Regulation of the Minister of National Education (9.5%). The ability to write a teaching material should be mastered by a prospective teacher to enable students to comprehend the material easily (52, 4%), by possessing an ability to write a teaching material will eventually assist teacher in directing the teaching and learning process. Hence, it can be used as a guide to implement the teaching and learning process (38, 1%).

Students’ perception as prospective teachers indicate, mostly in general, that an ability to write a teaching material is very necessary to master personally. They tend to assert that writing a teaching material is a crucial thing to teach with or without a regulation. On the other hand, a few students think that mastering an ability to write a teaching material is not really necessary to master. They tend to think that writing a teaching material are merely one of the demands confined in the Regulation of the Minister of National Education. In other words, the students are not aware that besides the advantages of mastering an ability to write teaching materials, there is also a demand that should be fulfilled by the teacher confined in the professional competence standards regarding the ability of writing teaching materials.

3.2. Students’ perception of argument in teaching material
According to the questionnaires given, it can be inferred that almost all prospective teachers view that an argument is one of a fundamental things in teaching material (95, 2%). The reason behind this result is revealed from the interview result. Argument in teaching material enables students to comprehend the material easily (95%), it is in line with the statement mentioned that the argument will provide more comprehensive explanation [7]. As a result, it will enable students to understand the material in an easy way.

Besides, according to students as prospective teachers, an argument will assist teacher to facilitate students to master critical thinking skills (5%). The students tend to think through the argumentation components. This tendency will enable students to think critically to learn something, not only comprehending what is happening but attempting to prove what kinds of evidence that refer to that phenomenon, why it is happening, what is underlying it. This perspective is relevant with the statement that argumentation contributes to critical thinking through warrant and rationalization.

3.3. Students’ perception on voltaic cell
In line with the result of the study, voltaic cell is a material that is considered difficult to learn by both students and teacher [11], most prospective teachers (66, 7%) delineate that voltaic cell is a complex material because there is a similarity with electrolysis cell related to positive and negative signals on the electrode, complexity in defining the occurrence of a reaction in the electrode, and difficulty in determining the direction of electron flow. Only a few students (33, 3%) assert that voltaic cell is not a difficult task to learn. It is because it can be demonstrated by practicum activities.

Students categorize voltaic cell material as an abstract concept (23, 8%) because the process or reaction occurs in the voltaic cells cannot be observed directly. Most students stress that voltaic cell is a concrete concept (76, 2%) because it is merely demonstrated in the daily life even though the reaction occurrence in the voltaic cells cannot be observed directly. This perception is a contradiction with Heron’s study where voltaic cell is considered as an abstract concept with concrete examples [10].

3.4. Difficulties faced on writing argument-based teaching material
According to the data obtained through questionnaire, it is revealed that students face difficulty in writing argument-based teaching materials (100%). Those complexities are revealed through the result of interview, common obstacles that occur is determining the argumentation topic and defining warrant component, backing, rebuttal, and qualifier. Students are not aware with the procedures of writing a teaching material and argumentation. It is because the students are only given an example of argument-based teaching materials and a brief explanation about the components of the argumentation. This study suggests that students should be given some basic knowledge regarding how to write and conduct a
teaching material and an argumentation. Therefore, it will facilitate them to write or conduct argument-based teaching materials.

3.5. Ability to develop an argument in a teaching material

Table 1 shows the students’ ability in writing an argument-based teaching material on voltaic cell material. It can be seen from their ability to mention each argument component. Table 1 indicates that most students possess the ability to make an argument in a teaching material at a low level. It has a limitation only in providing claims without an evidence. In other words, the evidence provided is not sufficient. This result is relevant with the result gathered from questionnaires and interview where the students deal with the complexity in determining warrant, backing, qualifier, and rebuttal to write a teaching material.

Table 1. Ability to develop an argument in a teaching material.

| Level | Amount of Students | Argument Examples |
|-------|-------------------|-------------------|
| 1 (Claim) | 12 | Voltaic cell is an electrochemical cell that can conduct an electric current (claim). |
| 2 (Claim + data or warrant) | 9 | Voltaic cells is an electrochemical cell that can generate electric current (claim) as proven by needless movement on a voltmeter set on the cell (data) circuit. |
| 3 (Claim + Data or warrant + Backing or qualifier) | 0 | |
| 4 (Claim + Data or warrant + Backing + qualifier) | 0 | |

4. Conclusion

Based on the result of the study, it can be inferred that most chemistry prospective teachers consider voltaic cell as a difficult material. This complexity is caused by the resemblance with electrolysis cell related to positive and negative signals on the electrode, complexity in defining the occurrence of a reaction in the electrode, and difficulty in determining the direction of electron flow. The students realize that a prospective teacher should possess the ability to write a teaching material and develop an argument as fundamental things. An argumentation will enables students to comprehend the material effectively. However, students’ ability in constructing an argumentation is still considered low. The complexity faced by the students in writing a teaching material lies in the difficulty of determining the argumentation topic, warrant and backing, rebuttal, and qualifier components.

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