Pre-Service Science Teachers (PSTs)’ Creative Thinking Skills on Atoms, Ions and Molecules Digital Media Creation

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Abstract. Atoms, ions and molecules are considered as abstract concepts that often lead to students’ learning difficulties. This study aimed at providing description of pre-service science teachers (PSTs)’ creative thinking skills on atoms, elements and compounds digital media creation. Qualitative descriptive method were employed to acquire data. Instruments used were rubric of PSTs’ digital teaching media, open ended question related to PSTs’ technological knowledge and pre-test about atoms, ions and molecules that were given to eighteen PSTs. The study reveals that PSTs’ creative thinking skills were still low and inadequate to create qualified teaching media of atoms, ions and molecules. PSTs’ content and technological knowledge in regard with atoms, ions and molecules are the most contributing factors. This finding support the necessity of developing pre-service and in-service science teachers’ creative thinking skill in digital media that is embedded to development of technological content knowledge.

1. Introduction
Atoms, elements and compounds are abstract concepts that commonly cause learning difficulties [1]. Appropriate technology in the term of digital teaching media can be used to help students’ comprehend the concepts more easily. Nevertheless, it is thought that students’ learning achievement is influenced more by teachers’ practice than the technology itself [2]. Thus, study on teachers’ competence in creating and implementing digital teaching media about atoms, ions and molecules is urgently required.

Various studies on in-service and pre-service science teachers (PSTs)’ competence to integrate technology in learning has been conducted. Especially for PSTs, it is found that their competence in integrating technology is significantly improved during the two years master program [3, 4]. PSTs of undergraduate program are not totally ready to effectively integrate technology into science teaching [5]. In addition, description of PSTs’ competence in integrating technology were also explored in various contexts such as inquiry-based learning [3], case-based learning [6] and internet use [7]. PSTs’ technology competence were also explored on various constructs and other factors, such as, gender, teaching experience and age [8]. Other factors affecting technology competence are the ICT learning...
experience [9], experience using ICT [10, 11], and fulfilling content representation [12]. However, none of the studies investigating PSTs’ technology competence related to creative thinking skill.

The investigation of PSTs’ creative thinking skill on digital science teaching media creation has not been performed. Therefore, this study aimed at investigating PSTs’ creative thinking skill on Atoms, Elements and Compounds digital teaching media creation. In this study, aspects of PSTs’ creative thinking skill was captured by means of analyzing digital teaching media of atoms, ions and molecules. Technology and content knowledge of PSTs were analyzed from their pre-test and open-ended question of technology integration in science learning.

2. Method
This study employed descriptive method to explore how PSTs’ creative thinking skill performed on digital teaching media about atoms, ions of molecules. Eighteen PSTs were involved in the study. The study was conducted in the context of school science course that aims to prepare PSTs to develop science learning material as well as the learning media for teaching science in junior high school.

Every science topics was carried out through eight following stages: 1) Identifying big ideas to assess content knowledge 2) identifying teaching procedures to assess pedagogical knowledge 3) identifying the use of technology to assess technological knowledge 4) planning to integrate appropriate teaching approach 5) planning to integrate appropriate technology for teaching Atoms, Elements and Compounds 6) planning to integrate technology for certain teaching method 7) Creating digital media for teaching Atoms, Elements and Compounds. PSTs’ creative thinking skills were investigated by analysing the digital media they made.

This study used multiple data sources which are rubric of digital teaching media, open-ended question on technological knowledge and pre-test about atoms, ions and molecules. The rubric of digital science teaching media consists of creative thinking skills indicator which are fluency, flexibility, originality and elaboration [13]. Open-ended questions about PSTs’ technological knowledge were embedded into course assignment. The questions asking about tools of technology that is appropriate for teaching atoms, ions and molecules as well as ways to overcome absence of the technology. Meanwhile, pre-test was given before the implementation of the course. The pre-test was arranged in the form of concept map task about atoms, ions. Data were analysed using qualitative approach. Creative thinking aspects performed in digital science teaching media were identified based on creative thinking skill indicators. Open-ended question exploring PSTs’ technological media was used to triangulate the data.

3. Result and Discussion
This section provides description of PSTs’ creative thinking skills appearing in digital science teaching media about atoms, ions and molecules. Moreover, the association of PSTs’ creative thinking and other variables which are content knowledge and technological knowledge are also discussed.

3.1. Pre-service Science Teachers(PSTs)’ Creative thinking skill on Fluency aspect
Fluency are indicated by a number of big ideas that the PSTs derived for the topic of Atoms, Elements and Compounds. The ideas are: 1) Classification of element 2) The development of atomic theory 3) Nomenclature of compounds 4) Periodic table of element and 5) Ions and Molecules. These ideas are fluently presented in the teaching media in the form of definition. This type of knowledge indicates PSTs’ content knowledge [14]. The example of digital teaching media slide presentation is shown in Figure 1. It is shown that PSTs fluently derive certain big idea into several information. However, it is found that mostly PSTs present the ideas by means of delivering one direct information.
The PSTs are also fluently generate teaching strategies appropriate in delivering the topic of Atoms, Elements and Compounds. Those strategy are lecturing with analogy, the use of elements’ characteristics cards and games. Games is one learning strategy that can be used to enhance creative thinking skills [15].

3.2. Pre-service Science Teachers’ Creative thinking skill on Flexibility

Flexibility can be identified when PSTs are able to perform the following ability: 1) generate various ideas, answers, questions as well as view problems from different perspectives (2) Search numerous alternative solution (3) change approach and thoughts [13]. It is found that all PSTs use Power Point. This finding echoes the lack of PSTs’ technological knowledge. It is also found that PSTs do not insert any more sophisticated aid to deliver the topic. This fact indicates the need of ICT course infused into teacher preparation program [10]. The only visual aid inserted in the digital media is pictures. Figure 2 shows the use of picture to endorse the delivery of Atoms, Elements and Compounds topic. This phenomenon is associated with less technological knowledge which is knowledge about hardware and software for enhancing the learning [14].

Based on figure 2, it is found that PSTs use static figures to deliver Atoms, Elements, Compounds and Mixtures. It implies the PSTs’ low ability to insert more sophisticated media which currently provided freely in internet. Thus, it is important to develop intervention so that the PSTs are fluently able to insert pictures, video as well as simulation into their digital science teaching media. The intervention can be in the form of instructional design based on technological pedagogical content knowledge (TPACK) [16].

Data from pre-test reveals that PSTs’ content knowledge do not guarantee their creative thinking skills. As a consequence, PSTs’ creative thinking skills need to be developed along with the program developing content knowledge and technological knowledge.
3.3. Pre-service Science Teachers’ Creative Thinking Skill on Originality and Elaboration

Originality and elaboration have not appear in the digital science teaching media. No one of the digital science teaching media contains new and unique statements. All the digital media contains common description and explanation delivering the topic of Atoms, Elements and Compounds. In contrast, originality refers to the ability to generate unusual combinations [13]. According to the digital media created, there is no feature performing pre-service science teachers’ originality to present unique software as well as digital application to teach Atoms, Elements and Compounds. Regarding this, an effort developing pre-service science teachers’ originality in building digital science teaching media is necessary. Specific program or training needs to be implemented in order to prepare PSTs in creating digital media. This finding support view about the necessity of technological pedagogical content knowledge within PSTs preparation program [9].

Elaboration is not performed in PSTs’ technological knowledge. Elaboration is indicated by the skill to enrich and develop an idea or product, add or derive details of certain object, ideal or situation to be more interesting. This skill is also associate with Association between PSTs critical thinking skill and technological knowledge can be bridged by program teaching technological abilities. One of the ability is coding [17].

4. Conclusion

Based on the study it is concluded that PSTs’ creative thinking skills were still low and inadequate to create qualified teaching media of atoms, ions and molecules. Creative thinking skill aspects that appears is limited to fluency and flexibility. The PSTs have not been developed originality and elaboration. PSTs’ content and technological knowledge in regard with atoms, ions and molecules are the most contributing factors. Meanwhile, content knowledge about atoms, ions and molecules does not guarantee PSTs’ creativity to create digital science teaching media. This finding support the necessity of developing pre-service and in-service science teachers’ creative thinking skill in digital media that is embedded to development of technological content knowledge.

Acknowledgments

The authors would thank to Dr. Phil. Ari Widodo, M.Ed. as the head of school science course, Ikmanda Nugraha, M.Pd. and Dr. Eka Cahya Prima as lecturers team of the course.

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