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KNOWLEDGE LEVEL AND SELF-CONFIDENCE ON THE COMPUTATIONAL THINKING SKILLS AMONG SCIENCE TEACHER CANDIDATES

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Abstract: *The trend of topics in today's education is computational thinking skills, which is used to help to solve complicated problems more easily. This study aimed to identify the level of knowledge and self-confidence of science teacher candidates (physics and biology) on computational thinking skills. The survey research design was used through a mixed-method approach, which combined quantitative and qualitative approaches. The quantitative study involved 1016 randomly selected groups of science teachers. In the qualitative study, 8 science teachers were chosen based on the scores obtained from the quantitative study. The questionnaire was used as a quantitative data collector tool to analyze descriptive statistics. Then, interview protocols were used as qualitative data collection tools and analyzed through theme creation. The findings show that the science teacher candidates have high level of knowledge and self-confidence. The implication of this study is very important for the teacher candidates because computational thinking can help to facilitate problems solving in everyday life. Teacher candidates need to be given knowledge and understanding of computational thinking skills, to have readiness and self-confidence in facing the challenges of the learning 21st-century skills.*

Abstrak: *Trend topik dalam bidang pendidikan masa kini adalah kemahiran pemikiran komputasional, yang digunakan untuk membantu menyelesaikan masalah yang rumit menjadi lebih mudah. Kajian ini bertujuan mengenal pasti tahap pengetahuan dan keyakinan diri calon guru sains (Fizik dan Biologi) terhadap kemahiran pemikiran komputasional. Reka bentuk kajian tinjauan digunakan melalui pendekatan gabungan (mixed-method), iaitu menggabungkan pendekatan kuantitatif dan kualitatif. Kajian kuantitatif melibatkan 1016 calon guru sains yang dipilih secara rawak mudah berkelompok. Manakala dalam kajian kualitatif melibatkan 8 calon guru sains yang dipilih berdasarkan skor yang diperoleh daripada kajian kuantitatif. Soal selidik digunakan sebagai alat pengumpul data kuantitatif dianalisis statistik deskriptif. Protokol temu bual digunakan sebagai alat pengumpulan data kualitatif dan dianalisis melalui pembentukan tema. Hasil kajian mendapati bahawa tahap pengetahuan dan keyakinan diri calon guru sains adalah tinggi. Implikasi kajian ini sangat penting bagi calon guru, kerana pemikiran komputasional dapat membantu memudahkan dalam penyelesaian masalah yang ada dalam kehidupan seharian. Calon guru perlu diberi pengetahuan dan pemahaman mengenai kemahiran pemikiran komputasional, supaya memiliki kesiapan dan keyakinan diri dalam menghadapi cabaran abad pembelajaran ke-21.*

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Kata kunci: *Physics Science Teachers Candidate, Biology Science teachers Candidate, Computational Thinking Skills, Knowledge, Self-confidence*

INTRODUCTION

Computational thinking skills are defined as a set of problem-solving skills based on computer techniques required for almost all careers, not just scientists but also in other fields, such as doctors, teachers, or farmers (Figueiredo & Alberto 2017). Computational thinking is defined by Wing (2011), as a thought process involving problem formulation and expressing solutions through information processing. It is explained again by Aho

(2012), who states computational thinking as a thought process involving problem formulation so that students can solve problems through calculation and generalization steps. However, the solution varies depending on the computing system and the problems that individuals face.

The study of computational thinking skills has been carried out by previous researchers. However, previous studies focused more on students, such as the studies Aman et al. (2011), Barr and Chris (2011), and Grover and Pea (2013). Moreover, a study from Belanger et al. (2018) also examined computational thinking skills among 10-16 year old students; it focused on problem solving. However, the research among teacher candidates has not been conducted by researchers (Aman et al. 2011). It was supported by Yadav et al. (2014) who say that the integration of computational thinking skills at university level is still low. This is illustrated by the observation of researchers on science teacher candidates in one University in Indonesia through the dissemination of google form questionnaire. The results indicate that teacher candidates have less knowledge about computational thinking skills. In fact, most science teacher candidates have never been exposed to computational thinking (Osman 2018). It is supported by Meritxell Estebanell et al. (2017), that the present day in the faculty of education has not yet formed a teacher candidates who is ready to teach computational thinking at a real school in the future, because to teach computational thinking requires knowledge and the teacher's self-confidence.

The knowledge and self-confidence in computational thinking skills among teacher candidates has been studied recently, but still very few studies specifically explain their knowledge and self-confidence. For example, a study by Bower and Falkner (2015) examined "pedagogical capability enhancement (including understanding, ability, technological knowledge, and self-confidence) computational thinking of school teachers". A self-confidence study found that 18 out of 32 teacher candidates (56%) at Australian universities expressed uncertainty and were not convinced to teach computational thinking skills in a real class. Two researchers have suggested that teachers lack understanding, ability, technological knowledge, and self-confidence in understanding the concept of computational thinking (Bower et al. 2017; Sentance & Andrew 2015). Overall, it is concluded that studies related to the knowledge and self-confidence of computational thinking skills among the teacher candidates have not been specifically identified.

Angeli and Jaipal-Jamani (2018) explain that systematic reviews on the teaching of computational thinking skills among teachers are still lacking in scientific articles as teaching references. Thus, in previous years there was evidence that the teaching at the faculty of higher education lacked the knowledge and skills to teach computational thinking skills among teacher candidates (Yadav et al. 2014). In Indonesia, a preliminary study was conducted by a researcher at the State Islamic University of Raden Intan Lampung. The results showed that as many as 31 people (51.7%) had never heard of computational thinking skills, 8 (13.3%) were doubtful, and 21 (35%) had ever heard about it. Candidates claim that they are less convinced of computational thinking skills, due to lack of knowledge (Osman 2018). This finding is supported by a recent study by Sands et al. (2018), that there are still very few teachers who have the knowledge and awareness of how computational thinking skills can be carried out in their classroom.

Based on the issues that the researchers have done earlier, this investigation is important in Indonesia. The aim of the study is in line with the 2013 curriculum policy which requires that in the learning implementation, the students should be given the freedom to think and solve the problems that are being faced, develop strategies to solve problems, and propose ideas freely and openly (Josip & Sinambela 2013). Computational thinking skills are one of the most useful skills to assist teachers and potential teacher candidates in understanding and strengthening the teaching and learning required in the 2013 curriculum. According to Machali (2014), the policy of the 2013 curriculum change is based on internal and external challenges faced by Indonesian people to prepare productive, creative, innovative, and effective generations. Ozcinar (2017) recommends that future studies need to examine computational thinking in the context of educational technology, investigate its adjustment and use in professional life, and the relevant concepts should be included in the definition of the future.

Computational thinking skills need to be introduced in Indonesia. This is in line with Endarta (2014) who views that computational thinking skills are essential and in line with the goals of 2013 curriculum learning in Indonesia, as it has been widely carried out in countries around the world. For example, China is an innovative talent advocate in various disciplines (Long et al. 2013). In England, it is as one of the subjects of the country's curriculum (*Department for Education England* 2013). In South Korea, it is one of the new curriculum subjects in 2018, which includes digital literacy, computational thinking, and programming (Choi et al. 2015). Education in Indonesia is responsible for increasing knowledge and self-confidence in computational thinking skills, such as by incorporating into the education curriculum and making one of the compulsory subjects of the faculty. As per findings found by Erdogan and Koseoglu (2012), the nature of science should be emphasized in the science curriculum to help every citizen in the country become lifelong learners and have sufficient scientific literacy level.

METHODOLOGY

This research applied a survey design with mixed-method approach, which combined quantitative approach and qualitative approach. As suggested by Wu (2018), studies related to computational thinking in science need to be collected by using a design of mix to collect quantitative and qualitative data. The use of mixed methods is intended to obtain clear and accurate information, and to understand the problem statement better than to do one method (Creswell & Creswell 2017). Participants of the quantitative study were 1016 science teacher candidates who were randomly selected from two different backgrounds (Biology and physics science). Meanwhile, the qualitative study participants were eight candidates of science teachers who were selected from the highest score in quantitative studies. The quantitative research instrument was questionnaire consisting of study demographics, questions on the level of knowledge and self-confidence in computational thinking skills. The questionnaire formulated in this study refers to the questionnaire administered by the previous expert, ie Yadav et al. (2014), Korkmaz et al. (2017), Feldhausen et al. (2018), dan Yağcı (2019). Meanwhile, the qualitative research instruments refer to the questionnaire administered by Bower et al. (2017). Quantitative data were analyzed by using descriptive statistics. Meanwhile, the qualitative data were analyzed through the formation of themes.

STUDY RESULT

Figure 4.1 shows the mean value of knowledge and confidence in computational thinking skills. The results show that the mean for the level of knowledge in computational thinking skill among science teacher candidates was high (mean = 78.54; sp 6.48). Furthermore, the results of the study also found that the mean for the level of self-confidence of science teacher candidates on computational thinking skills was high (min = 78.63; sp = 7.03). Details are shown in figure 1:

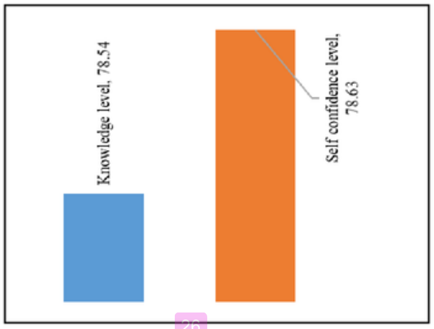

Figure 1 Mean Value of the Level of Knowledge and Self Confidence in Computational Thinking Skills

Furthermore, the findings show that the level of knowledge for each construct involved namely (i) Knowledge of CT content is high (mean = 75.00; sp = 7.73); (ii) General pedagogical knowledge is high (mean = 79.27; sp = 8.25); (iii) Knowledge of CT pedagogic content is very high (mean = 82.84; sp = 9.06); and (iv) Knowledge of CT strategy is high (mean = 77.93; sp = 8.02). The details are displayed in figure 2 below.

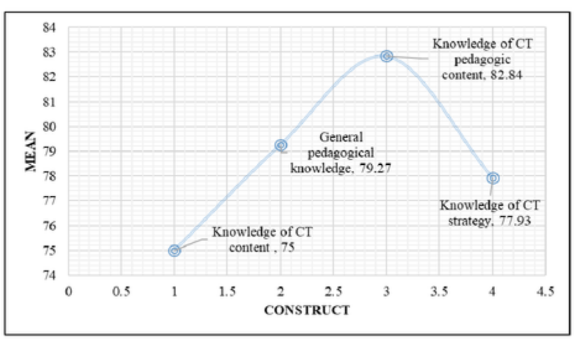

Figure 2 Mean Score of Knowledge Level Constructs on Computational Thinking Skills

The level of confidence in each construct involved, ie (i) The very high expectations (min = 81.81; sp = 8.71); (ii) High self-efficacy (min = 78.48; sp = 8.87); (iii) Higgh optimists (min = 76.13; sp = 9.69); and (iv) High endurance (min = 77.98; sp = 9.03); (v) High experience (min = 78.43; sp = 9.03). In details, it is shown in figure 3:

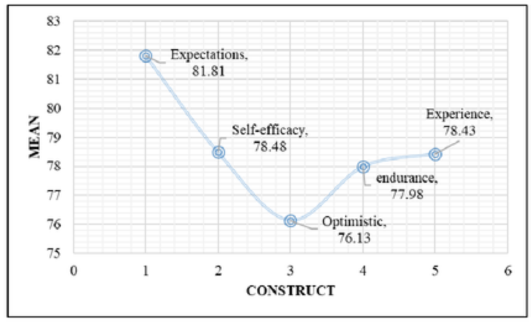

Figure 3 Mean Score of Knowledge Level Constructs on Computational Thinking Skills

Furthermore, the views of science teacher candidates on computational thinking is not yet familiar with the term computational thinking. Here is an example of interview quotes obtained:

Table 1. Sample interviews

No	The subject of the study	Interview quotes
1	A	"... Actually, I have never known what computational thinking is. After this research, I slowly began to know computational thinking ".
2	B	"... In general, I have never heard of so-called computational thinking so far, when you conducted research on computational thinking, I tried to read one of the journals that involved understanding computational thinking".

In general, this study has implications that in Indonesian education, to improve teachers' profession in the digital age can be done through the necessary skills upgrades.

DISCUSSION

The world of education today always changes dynamically following the times. Therefore, teachers must be willing to follow these developments to achieve better education goals as aspirations of the Indonesian people (Rahayu et al. 2017). This is because the teacher is one of the important figures responsible for the teaching and learning process (Koç 2015). In creating an effective teacher, the faculty of education should be able to build and produce professional teachers in their respective fields including science. Hence, current science teacher candidates are required to possess computational thinking skills, not only computational thinking skills through the use of technology such as computers, but also involving human cognitive processes in solving complex problems (Cooper et al. 2010; Shi et al. 2014).

Based on the research conducted, it is found that the level of knowledge of science teacher candidates is high. This means that science teachers candidate have the essential knowledge as an initial capital to teach in a real school. However, based on interviews conducted by researchers, the findings are less appropriate. The respondents' views are related to the knowledge of computational thinking skills is "not knowing", new teachers know when the researcher conducts research. The findings of this study are consistent with the study of Bower et al. (2017), who found that most teachers candidate have not yet recognized the term computational thinking as the basic concept in the new digital technology curriculum. Some causes of lack knowledge of computational thinking skills are that teachers are less exposed to computational thinking in the early stages of their studies (Yadav et al. 2014). It is supported by Meritxell Estebanell et al. (2017), that the cause of computational thinking skills is due to the lack of specialized knowledge.

Lack of knowledge has a negative impact on self-confidence, as in Bower and Falkner (2015) study found that if teachers lack general understanding and knowledge of computational thinking skills, self-confidence also decreases. In this study, most science teacher candidates define computational thinking as one of the skills that are always closely related to technology such as computers. This view is less in line with a study by Selby and Woollard (2013), that computational thinking is not limited to the use of technology, it is as a cognitive or mental, human, and non-mechanical process. Similarly, some experts believe that computational thinking skills are used to help to solve complex problems in human life (Aho 2012; Barr & Chris 2011; CSTA 2011; Selby & Woollard 2013; Sentance & Andrew 2015; Swaid 2015; Tsai & Tsai 2017; Wing 2006), either using computers or involving human cognition. This is supported by CSTA and ISTE (2011) that computational thinking is an approach to problem solving in a way that can be implemented with computers, but is not limited to just using a computer.

In the classroom, computational thinking skills emphasize cognitive processes (Selby & Woollard 2014; Sung et al. 2016). Meanwhile, according to Ellis and Tod (2013), human behavior can illustrate individual attitudes in learning because it is a strategy to promote the behavior that is needed in learning. Brennan and Resnick (2016) also stated that the model of computational thinking skills is often used to enhance their understanding, to create relationships with others in the technology world around the individual. In addition, Powell and Tod (2014) suggest that learning behavior reflects the social, emotional and cognitive developments of students who depend on their previous learning experience. Based on the above views, it can be asserted that students are not only tool users but also as tool builders. According to Korkmaz et al.

(2017), current students can develop their own way of thinking when they realize that computers can produce automated and effective solutions in solving problems. Integration of information and communication technologies is believed to meet the current generation of learning styles (Osman et al. 2013).

Furthermore, one of the constructs of knowledge is general pedagogy. According to Morine-Dershimer and Kent (1999), general pedagogical knowledge is developed from experience. In general pedagogical knowledge, studies are high. This means that the subject has had experience in relation to that skill. Meanwhile, the findings on CT pedagogic knowledge are very high. According to Gess-Newsome (1999), pedagogical content knowledge can synthesize all the necessary knowledge to become an effective teacher. Therefore, this knowledge is very important to both teachers and teacher candidates. CT pedagogical content knowledge can be developed by teachers by using existing content knowledge. Clarified by Han (2014), pedagogical content knowledge can be developed not only based on the level of understanding of knowledge but also involving the level of teacher value placed in each domain of knowledge possessed by the teacher. Since its introduction by Shulman (1987) over the past 30 years, an understanding of the manifestation and development of pedagogical content knowledge has been investigated to illustrate the dynamic nature of the construction of pedagogical content knowledge itself.

In addition, the construct of self-belief is self-efficacy and experience. Nurasika (2017) states that individuals with higher self-efficacy tend to have the ability to manage and complete assignments to achieve certain results despite difficulties. The self-confidence in this study is high. When the individuals have low self efficacy, they tend to feel the difficulty in completing the assignment given. They feel less confident and committed to carrying out their duties (Adicondro & Purna 2011). People with high levels of self-efficacy will be more successful in their lives than people with low levels of self-efficacy (Jaengaksorn et al. 2015). In addition, in recent years Sarıcoban (2015) provides a view of self-efficacy, which is the extent to which one's own strength to accomplish the task of achieving that goal. In performing the required capabilities, it requires four types of teacher experience including experience of success and failure, physiology and affective experiences, experiences or skills and oral persuasion (Bandura 1997; Tschannen-Moran & Hoy 2001).

Overall, the above statement is appropriate when the knowledge and beliefs of science teachers candidate are at a high level because previous studies on Indonesian education technology have been extensively analyzed. For example, Yuliati (2016) who developed learning models for physics teachers, the study from Gunawan et al. (2017) about interactive multimedia teacher candidates, use of technology, information and communication, Internet-based learning (Effendi 2016; Farida 2012; Riwayadi 2013; Siahaan 2012), and e-learning (Batubara 2017; Sari et al. 2017; Siswanto et al. 2016; Thomas & Setiaji 2014). Teacher candidates justify their understanding of computational thinking related to technology. The presence of students has also been widely introduced to technology. For example, the study of Safrudin et al. (2019) about technology-based learning to improve student independence, Kamil et al. (2019) and (Mardhiyana & Nasution 2019) in the fourth industrial era. In addition, Gunawan et al. (2019) conducted training related to the utilization of information and communication technology.

CONCLUSION

In conclusion, this study is very important to know exactly about the knowledge and self-confidence of the computational thinking skills possessed by a science teacher candidate. If given the opportunity to carry out serious training from time to time, prospective teachers can improve their knowledge and the rest improve their self-esteem in computational thinking skills. Therefore, all parties involved in the education world in Indonesia should work together to increase their knowledge and confidence in computational thinking as one of the 21st-century basic skills.

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