JPII 11(1) (2022) 119-128

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

PROSPECTIVE SCIENCE TEACHERS' SELF-CONFIDENCE IN COMPUTATIONAL THINKING SKILLS

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DOI: 10.15294/jpii.v11i1.33125

Accepted: November 3rd 2021. Approved: March 30th 2022. Published: March 31st 2022

ABSTRACT

This study aims to analyze prospective science teachers' self-confidence in computational thinking skills on three main points: (i) prospective science teachers' self-confidence in computational thinking skills, (ii) differences in prospective science teachers' self-confidence in computational thinking skills as per gender, and (iii) differences in prospective science teachers' self- confidence in computational thinking skills as per expertise (Biology and Physics). A quantitative cross-sectional survey methodology was used as the research design. A total of 1023 prospective science teachers (biology and physics) were randomly selected as the research sample from the 1959 total population. Data were collected using a self-confidence questionnaire on computational thinking skills. The adaptation results were assessed first by five experts before being tested on 74 prospective science teachers from different universities. The results show that prospective science teachers' self-confidence in computational thinking skills was generally high (Mean = 78.57). The Mann-Whitney U test found no difference in prospective science teachers' self-confidence in computational thinking skills as per gender (Mean= 78.05, SD= 9.03 for male, Mean= 78.73, SD= 6.86 for female, with a value of F= 6.028, Z= -0.891, Sig= 0.373> 0.05). The Independent Sample t-test also showed no difference in prospective science teachers' self-confidence in computational thinking skills as per expertise. This study concludes that prospective science teachers have high self-confidence in computational thinking skills as crucial skills in the science teaching profession.

Keywords: computational thinking skills; prospective science teachers; self-confidence

INTRODUCTION

In this 21st-century education, teaching skills are critically important where teachers are required to be flexible (Yusuf et al., 2018; Sofiana et al., 2019; Ali, 2020; Gade, 2020; Astuti et al., 2021; Pahrudin, 2021). Digital literacy is an integral part of the 21st-century teaching skills as it provides the workforce to function more effectively (Van Laar et al., 2019; Litster et al., 2020; Lee & Malyn-Smith, 2020; Mouza et al., 2020; Kocak et al., 2021). Some experts call all these skills with the term "computational thinking skills," a skill that aids in the solution of complex challenges in human life, design systems and understanding human behavior by drawing basic concepts to computer science which is the key to the success of almost all professions today (Barr & Stephenson, 2011; CSTA, 2011; Wing, 2011; Aho, 2012; Selby & Woollard, 2013; Sentance & Csizmadia, 2015; Swaid, 2015; Tsai & Tsai, 2018; DiSessa, 2018; Carpenter et al., 2020; Kale & Yuan, 2021; Bati & Ikbal Yetişir, 2021).

There are four basic components of computational thinking skills: decomposition, pattern recognition, abstraction, and algorithms (Wing, 2006; Barr & Stephenson, 2011; Selby & Woollard, 2013; Suherman et al., 2021). Teachers need to make changes in line with current demands because teachers have a responsibility for the development and success of students. These changes are important so that teachers have high com-

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petitive abilities (Maulana et al., 2015; Ariffin et al., 2018; Engkizar et al., 2018; Yamamura et al., 2019; Hu et al., 2021). These skills must be possessed since a person chooses a profession as a teacher or is called a prospective teacher (Sawchuk, 2013; Sandholtz & Ringstaff, 2014; Uerz et al., 2018; Rantala & Khawaja, 2021). Equipping prospective teachers with computational thinking skills cannot be separated from the role of various parties, one of which is universities. Yadav et al. (2014), Babaei & Abednia (2016), Lai (2021), and Syafril et al. (2021) state that computational thinking skills are still underutilized in higher education. The faculty of education has not prepared teacher candidates fully with computational thinking. Bower et al. (2017) it is found that 18 out of 32 prospective teachers at Australian Universities found lack of confidence and understanding in computational thinking (Belo et al., 2014; Cesar et al., 2017; Del Olmo-Muñoz et al., 2020).

Some researchers state that computational thinking skills need to be provided to every individual who chooses to be a teacher or prospective teacher. Equipping prospective teachers is not only limited to computational thinking skills but what is more important is growing self-confidence in computational thinking skills. Prospective teachers who are very close to computational thinking skills are prospective biology and physics teachers (Taub et al., 2015; Tucker-Raymond et al., 2021; McDonald et al., 2022). Niss (2018) and Syafril et al. (2021) convey that the main goal in physics is problem-solving skills. This statement is in line with the views of Bonner et al. (2021), which says that the characteristic of teachers with good problem-solving skills is being able to transfer knowledge and understanding to the actual situation. Problem-solving skills significantly affect the learning process carried out by teachers (Ding, 2014). However, the current issue is that problem-solving skills are somewhat separated in physics education (Al-Balushi et al., 2020).

Kopcha et al. (2014), Mourlam et al. (2019), and Taimalu & Luik (2019) explain that the skills that need to be improved by prospective teachers today are the integration of science and technology with problem-solving skills in the learning process, including science learning. One of the current problem-solving skills teachers must master is computational thinking skills (Guzdial, 2016; Angeli, 2021). Wing has introduced this skill since 2006, which refers to integrating technology with problem-solving. Computational thinking skills are in great demand by researchers in various countries around the world (Ateşkan & Hart, 2021; Tekdal, 2021). Castro et al. (2021) suggest that computational thinking skills allow students to solve problems through detailed calculation steps and algorithms. Teacher self-confidence has a crucial role in succeeding in today's computational thinking skills in the teaching profession (Voogt et al., 2015; Kavenuke et al., 2020; Van Twillert et al., 2020). Self-confidence refers to the ability of teachers to have a positive view of themselves without the need to compare themselves with other teachers (Zapko et al., 2018; Herron et al., 2019; O'Flaherty & Costabile 2020; Watson et al., 2021). Low self-confidence will negatively affect the teacher's profession and professionalism (Hasan et al., 2014; Aini et al., 2019; Daumiller et al., 2021). Belanger et al. (2018) state that self-confidence in computational thinking skills needs to be developed for this purpose.

Previously, several researchers conducted a study on computational thinking skills, such as Lee & Francis (2018), Kavenuke et al. (2020), Luo et al. (2020), Fessakis & Prantsoudi (2019), van Ingen Lauer & Ariew (2022), Güner & Erbay (2021), and Yorkovsky & Levenberg (2021). In general, these researchers focus on various issues related to school students. On the other hand, computational thinking skills are crucial for teachers, including science teachers, especially self-confidence. According to Bouck & Yadav (2020), computational thinking skills help teachers solve problems, design a system, and understand human behavior by describing them through basic computer science concepts. Because of the importance of computational thinking skills, this study analyzes prospective teachers' self-confidence in computational thinking.

METHODS

This research was carried out using a quantitative methodology with cross-sectional survey designs. Data were collected only once throughout the study from the sample involved to obtain information according to the research focus: (i) prospective science teachers' self-confidence in computational thinking skills, (ii) differences in prospective science teachers' self-confidence in computational thinking skills as per gender, and (iii) differences in prospective science teachers' self-confidence in computational thinking skills as per expertise (Biology and Physics). Researchers can collect detailed and comprehensive information on the variables through cross-sectional survey designs (Creswell & Creswell, 2017). Cross-sectional survey designs analyze various research variables related to one issue without questioning why that variable is in that issue (Creswell & Creswell, 2017).

This study involved 1023 prospective science teachers (Biology and Physics) who were randomly selected from the 1959 total population of prospective science teachers at two public universities in Lampung, Indonesia. However, the actual data of this study only had 1016 prospective science teachers because there were seven prospective teachers whose data could not be used because they did not respond ideally to the questionnaire. The number of research samples in detail is as presented in Table 1.

Table 1. The Research Sample of Prospective Science Teachers' Self-confidence in Computational Thinking Skills

Prospective Science Teachers (Expertise/University)	Population	Sample	Percentage (%)
Biology/Universitas Lampung	244	174	17,00%
Physics/Universitas Lampung	221	157	15,35%
Biology/Universitas Islam Negeri Raden Intan Lampung	1020	419	40,96%
Physics/Universitas Islam Negeri Raden Intan Lampung	474	273	26,69%
Total Sample		1023	100%

This study used a self-confidence questionnaire on computational thinking skills. The questionnaire consists of 34 items measuring five constructs of self-confidence on computational thinking skills: Expectation, Self-confidence, Optimism, Resilience, and Experience. The questionnaire used a five-choice Likert scale: 1. Very Uncertain (VUC), 2. Uncertain (UC), 3. Less Certain (LC), 4. Certain (C), and 5. Very Certain (VC). Before the questionnaire was adapted to collect data, the questionnaire was assessed by five experts with 7 to 21 years of experience to see the suitability of the items with the five constructs of self-confidence in computational thinking skills.

After the process was completed, the questionnaire was then piloted to 74 prospective science teachers from different universities from where the actual research was conducted. The pilot study was to review the validity and reliability of the adapted questionnaire. The validity of the instrument was seen using the corrected item-total correlation by correlating the item score with the total score of all the items in the questionnaire that will be used and correcting the items that have overestimated correlation coefficient values, or by comparing the calculated R_{count} with R_{table} (Pallant, 2013). Based on the number of respondents in the pilot study (74 prospective science teachers), a R_{table} of 0.226 was found with a significant value of 0.05. The validity value obtained was R_{count} = 0.366 to 0.574, R_{table} = 0.226, Sig = 0.005. Referring to the corrected item-total correlation in general, the value obtained is above (R_{table} = 0.226). The only item scored below R_{table} is item TY24, an item in the durability construct (0.024 < 0.226 R_{table}). The TY24 item was dropped from the questionnaire of self-confidence on computational thinking skills for data collection.

After testing the validity, the questionnaire reliability test was conducted to ensure the consistency of the questionnaire to be used. The reliability of the questionnaire was assessed using internal consistency (Cronbach Alpha). The overall reliability value for this questionnaire is = 0.945. While the value for each construct is (Expectation = 0.849. Self-confidence = 0.844. Optimism = 0.848. Resilience = 0.847. Experience = 0.851). In general, experts state that the reliability value of a research instrument is between 0 to 1, and the value 0.60 to 0.70 is the lowest value that is scientifically acceptable (Robinson et al., 2013). The self-confidence questionnaire on computational thinking skills has a high-reliability value in the expert's view. In other words, the questionnaire has high consistency.

After processes related to the questionnaire were completed, data collection was carried out as previously explained that this research data was collected only once throughout the study under the characteristics of cross-sectional survey designs. Then, the data obtained were analyzed using descriptive statistics, Mann-Withney U non-parametric inference statistics, and independent sample t-test parametric inference statistics assisted by the Statistical Package for Social Science (SPSS) Windows version 26.0 software to obtain answers to the three research focuses as described before (Grant et al., 2016).

RESULTS AND DISCUSSION

Following the focus of this research, the results of the study describe prospective science teachers' self-confidence in computational thinking skills, differences in prospective science teachers' self-confidence in computational thinking skills as per gender, and differences in prospective science teachers' self-confidence in computational thinking skills as per expertise (Biology and Physics). To further strengthen the presentation of the results of this study, the researcher first describes the profile of the research respondents in Table 2.

Table 2. Profile of Research Respondent

Respondent		Number	Per (%)
Based on gender	Male	141	13.9%
	Female	875	86.1%
	Total	1016	100%
Based on expertise	Physics	427	42.0%
	Biology	589	58.0%
	Total	1016	100%

Of the 1016 prospective science teachers sampled in this study, 141 (13.9%) were male, and 875 (86.1%) were female. Meanwhile, based on expertise, it was found that 427 people (42.0%) were prospective physics teachers, and 589 people (58.0%) were prospective biology teachers.

Furthermore, Figure 1 illustrates the results of research on the prospective science teachers' self-confidence in computational thinking skills. Generally, from the analysis results, prospective science teachers' self-confidence in computational thinking skills is high (Mean = 78.57). The scores for each construct were: Expectation (Mean = 81.81, SD = 8.71: very high), Self-confidence (Mean = 78.48, SD = 8.87: high), Optimism (Mean = 76.13, SD = 9.69: high), Resiliance (Mean = 77.98, SD = 9.03: high), Experience (Mean = 78.43, SD = 9.03: high).

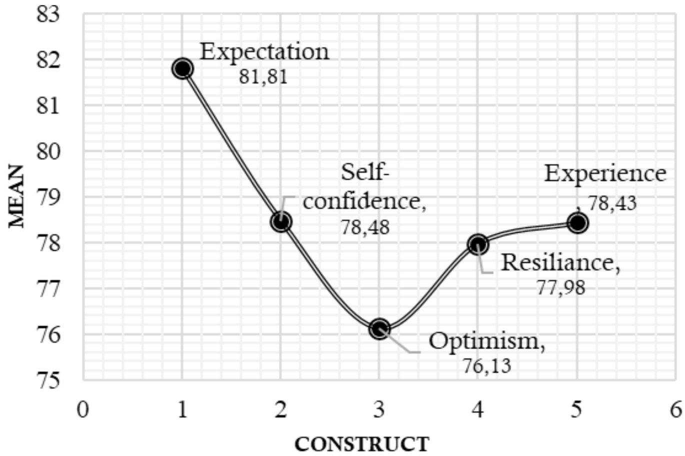

Figure 1. The Research Results on Prospective Science Teachers' Self-confidence in Computational Thinking Skills

Furthermore, the differences in prospective science teachers' self-confidence in computational thinking skills as per gender are explained. Mann-Whitney U non-parametric inference statistic was used to see the difference. The results of the analysis using Mann-Whitney U are presented in Table 3.

Table 3. Mann-Whitney U Analysis: Differences in Prospective Science Teachers' Self-confidence in Computational Thinking Skills as per Gender

					Levene's Test		Mann-Whitney U		
	Gender	N	Mean	SD	F	Sig.	Z Score	Ranking Mean	Sig. (2-tailed)
Self-Confidence	Male	141	78.05	8.03	6.028	0.014	-0.891	488.07	0.373
	Female	875	78.73	6.86				511.79	

α= 0.05

The results of the Mann-Withney U analysis in Table 3 show no difference in prospective science teachers' self-confidence in computational thinking skills as per gender (Mean = 78.05, SD = 9.03 for males, Mean = 78.73, SD = 6 .86 for women, with a value of F= 6.028, Z= -0.891, Sig= 0.373> 0.05).

Furthermore, the differences in prospective science teachers' self-confidence in computational thinking skills as per expertise (biology and physics) are explained. The difference was seen using independent parametric inference statistics sample t-test. The analysis results using the independent sample t-test are presented in Table 4.

Table 4. Independent Sample t-Test Analysis: Differences in Prospective Science Teachers' Self-Confidence in Computational Thinking Skills as per Expertise

Expertise					Levene's Test		t-test		
		N	Mean	SD	F	Sig.	T	df	Sig. (2-tailed)
Self-Cofidence	Physics	427	78.28	6.98	0.081	0.777	-1.370	1014	0.171
	Biology	589	78.89	7.07					

α= 0.05

The results of the independent sample t-test analysis in Table 4 also show no difference in prospective science teachers' self-confidence in computational thinking skills as per expertise (Mean = 78.28, SD = 6.98 for prospective physics teachers, Mean = 78.89, SD = 7.07 for prospective biology teachers, with a value of t = -1.370, Sig = 0.171> 0.05).

21st-century skills are essential for teachers to face today's educational challenges. One of the skills that teachers need is computational thinking. It is necessary to consider various ways to introduce computational thinking skills in Indonesian education through research and scientific publications. Students can develop their thinking skills and solve problems automatically and effectively in certain situations (Korkmaz et al., 2017; Çakır et al., 2021). In line with the prospective science teachers' high self-confidence in computational thinking skills, as shown by this study, it will positively contribute to students' development (Siswanto et al., 2016). As part of problem-based learning, the integration of 21st-century skills is thought to match today's generation of learning styles (Osman et al., 2013; Osman & Kaur, 2014). It is essential to implement computational thinking skills in everyday behavior (ISTE, 2015).

Teachers' self-confidence in computational thinking skills includes handling complex problems (Barr & Stephenson, 2011; Woollard, 2016; Feldhausen et al., 2018). For this reason, these skills need to be fully mastered by prospective teachers, both male and female. Yadav et al. (2014) explain that male and female teacher candidates are equally interested in improving computational thinking skills. This view is in line with the results of this study, which found no difference in prospective science teachers' self-confidence in computational thinking skills as per gender. It can be assumed that the increase in prospective science teachers' self-confidence in computational thinking skills is because computational thinking is closely related to the fields of Science, Technology, Engineering, and Mathematics (STEM). In addition, Swaid (2015) states that computational thinking skills are being introduced and used in various STEM disciplines. On the other hand, this study found no difference in prospective science teachers' self-confidence in computational thinking skills per gender, and it was also assumed that male and female prospective science teachers had the same time and opportunity to explore this subject. Even in universities, the intervention and learning that male prospective science teachers and female prospective science teachers participate in are the same.

The results also find no difference in prospective science teachers' self-confidence in computational thinking skills as per expertise (biology and physics). According to Song et al. (2021), Chevalier et al. (2022), and Ung et al. (2022), computational thinking has potential in various fields of science. Barr & Stephenson (2011), Chan et al. (2021), and Tikva & Tambouris (2021) use computational thinking skills as the basis for conceptual thinking in social research to generalize concepts in various facts of life. Language arts learners use computational thinking skills to analyze different language features when constructing different sentences. Computational thinking skills in society can foster creativity (Mishra et al., 2013). In science (biology and physics), learning is always related to problem-solving in real life. Niss (2018) finds that problem-solving skills are one of the main goals in learning Physics. Ding (2014) believes that problem-solving affects the learning of prospective physics teachers. Likewise, in biology, problem-based learning is also integrated with computational thinking skills (Osman & Kaur, 2014). It is also assumed that the various rationales presented are why there are no differences in the self-confidence of prospective science teachers (biology and physics) on computational thinking skills.

The implications of this research are significant for prospective science teachers, whether male, female, or as per expertise (biology and physics), because computational thinking skills can facilitate the problem-solving process in learning and the daily lives of teachers. Prospective science teachers need to seriously increase their self-confidence in computational thinking skills by showing confidence in using various aspects and content to encourage creativity in problem-solving. Yadav et al. (2016), Kong & Wang (2020), and Relkin et al. (2021) incorporate computational thinking skills in various ways to sharpen teachers' knowledge of 21st-century skills. Prospective teachers become essential agents in computational thinking skills because they make prospective teachers see the relationship between computational thinking skills and their scientific disciplines. Prospective teachers who understand computational thinking skills early are aware of their application both inside and outside the classroom (Creely et al., 2021; Hooshyar et al., 2021). Therefore, prospective science teachers in Indonesia need to be given computational thinking skills to make these teachers more professional in carrying out various educational tasks (Angeli et al., 2016; Bocconi et al., 2016; Angeli & Jaipal-Jamani, 2018).

Computational thinking skills are essential and aligned with today's learning goals as they are practiced widely in many countries of the world. China supports innovative talent in multiple disciplines associated with computational thinking skills (Hurrell et al., 2013). Computational thinking skills are a part of England's state curriculum (Pérez-Marín et al., 2020). In 2018, South Korea added computational thinking skills to the curriculum, including digital literacy, computational thinking, and organizing (Choi et al., 2015). Thus, at the same time, Indonesia should pay special attention to teachers, including science teachers, to increase their self-confidence in these computational thinking skills.

CONCLUSION

Science learning emphasizes problem-solving skills according to the demands of current developments. This emphasis requires teachers and prospective teachers to have various other skills outside of their professional skills. Experts call these skills the term computational thinking skills. Teachers and prospective teachers must master these skills and be agents of change to these computational thinking skills needed in various professions in the 21st century. Teachers and prospective teachers face various educational problems today, and computational thinking skills are assumed to help teachers and prospective teachers deal with these problems. By incorporating computational thinking skills into the teacher education curriculum and through continuous coaching to respond to dynamic challenges and changes in the world of education from time to time, the education skills must be a fertile place to sow these skills.

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