Science Teacher's Self-Confidence on Integrating Computational Thinking into Classroom Pedagogies for Teaching and Learning

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Abstract

With the awareness on the significance of digital skills in relation to Information and Communication Technology, many scholars across the globe indicated the need to include coding starting with primary education up to secondary school science curriculum. In addition, various benefits can be obtained from teachers' self-confidence in teaching that bring about a positive impact on integration of computational thinking skills which will enable students' improvement of learning. Science teacher's self-esteem with self-confidence is essential component that enhance effective integration of computational thinking into classroom pedagogies for teaching and learning. The study investigated teacher's self-confidence on integrating computational thinking into their classroom instructions. It adopted survey research design. While a total of 40 online questionnaires were sent to the respondents, 32 were retrieved and hence used for analysis using SPSS version 24. Results indicated that science teachers demonstrated higher level of self- confidence on computational thinking. It also indicated that there is no significant difference on self-confidence to integrate computational thinking between genders. Science teachers need to improve their self-confidence in computational thinking skills by demonstrating confidence of knowledge/skills related to programming in various content areas to promote creativity and problem-solving skills among learners.

Keywords: Self-confidence; Computational thinking; Pedagogies; Teacher; Classroom

Introduction

Background and Rationale

Today, promoting the 21st - century skills is the main focus in world of education in many countries including Malaysia as these are the skills required in digital era to be incorporated in

the curriculum. According to Talib, Aliyu, Aliyu, Maimun, Malik, Anggoro, and Ali (2020), 21st-century skill is characterized by the emergence of supercomputers, robotics, automation vehicles, genetic edits, and neurotechnology developments that enable humans to optimize brain function. Malaysian education system needs to make changes in line with the digital transformation to remain globally competitive, as the teachers have the responsibility for the improvement of academic and student achievement in the classroom (Maulana, Helms-Lorenz, & van de Grift, 2015) Hence, a prospective teacher needs to have the expectation of a strong teaching skill (Sawchuk, 2013).

The needs for classroom teachers to improve their computational thinking skills for the effective integration of technology, science as well as problem-solving in the teaching and learning process have been emphasized by many researchers (Quitério Figueiredo, 2017). This is because the integration of computational thinking skills will give teacher more confidence toward implementation of revised curriculum. Besides that, computational thinking skills involve the formulation of problems to be solved by students through calculation of steps and algorithms.

According Figueiredo and Alberto (2017), computational thinking skills is defined as a set of problem-solving skills based on computer techniques that are key to success in almost all career and also linked to problem solving with surroundings.

Review of Related Literature

Teachers' Self-confidence for Classroom Instructions. Self-confidence can be viewed as a self-esteem that represents individual's competence in specific characteristic within certain contexts, domains and situation (Guo, Connor, Yang, Roehrig, & Morrison, 2012), One of the key role of self-confidence of classroom teachers is their ability to have self-control in their instructions. This opinion was formed on the bases of argument by Furman Shaharabani & Tal (2016), in which he stated that, self-confidence as well as work performance have very strong and positive relationship. Similarly, Todorescu, Popescu-mitroi, & Greculescu (2015) pointed out that, various benefits can be obtained from high self-esteem with self-confidence in teaching which bring about a positive impact on learning, thus enabling students to improve. Therefore, a conclusion that could be drawn from earlier literature is that self-confidence is an important trait that classroom teachers should possess before jumping into real class activities.

A study was conducted by Guo, Connor, Yang, Roehrig, and Morrison (2012) to examine the effects of self-confidence of a teacher, education, and length of experience on observed classroom practices across two dimensions — support of a teacher for the learning of student and period spent in academics. The study revealed that instructors with greater sense of self-confidence than those with lesser self-confidence to display more support by providing positive environment for classroom. They believed that educators with a strong sense of confidence have positive influence on student's learning and motivation, thereby providing instructional skills until learners showed progress in learning.

Computational Thinking. The term 'computational thinking' was first brought up by Wing (2006) as a process involving solving problems, designing systems, and understanding human behaviour, by drawing on the concepts fundamental to computer science. Other than that, computational thinking skills can be defined as involving in the abovementioned skills by

integrating the fundamental computer science concepts (Swaid, 2015). Generally, the expert agreed that computational thinking skills are among the skills required to solve either routine or non-routine problem in human life. The study from Swaid (2015) provided a similar definition of computational thinking skills that need to reflect the breath of computer science fields. Similarly, computational thinking was also defined as a general analytic approach to understanding human behaviour, problem-solving and designing systems (Sengupta, Kinnebrew, Basu, Biswas, & Clark, 2013). As cited by Grover and Pea (2013), computational thinking was revisited by Wing (2008) in which he further clarified it as the processes of thinking involved in formulating solutions to the problems, which were later represented in a form that could be executed effectively by agent of information processing.

With awareness of digital skills significance in relation to information technology, Many researchers across the globe express the need to include coding starting with primary education to secondary school curriculum, because scholars begin to accept computational thinking skills as a core element for Science, Technology, Engineering and Mathematics (STEM) subjects (Garcia-Penalvo, 2016). According to Wing (2006), Barr and Stephenson (2011), as well as Selby (2013), state that there are four basic components in computational thinking skills which are decomposition, pattern recognition, abstraction and algorithms. Table 1 showed the details of components and definitions of computational thinking skill.

Table 1
Component of Computational Thinking

No	Component of Computational Thinking	Definition
1	Decomposition	Solving problems into smaller sections and more details, from each section can be more easily identified and analysed
2	Pattern Recognition	Identifying patterns and equations in solving problems easier
3	Abstraction	Making a problem more understandable by reducing unnecessary details
4	Algorithms	Developing the step by step instructions for solving problem
5	Evaluation	Ensuring the solution is a good one

Teacher's Confidence on Computational Thinking. Advance problem solving skills need computational thinking skills such as individual calculations and thinking skills. However, if teachers have good computational thinking skills but lack if self-confidence, it may cause a negative impact on a subject learned in classroom and the objectives of learning will be less effective (Bean, Weese, Feld Hausen, & Bell, 2015). Hence, the confidence of science teachers before teaching is importance to make education more effective and students can reach confidence level with their teachers.

A study was conducted by Talib, Aliyu, and Zawadzki (2019) to look into the potential of developing computational thinking skills using Graphic Calculators technology in Science Technology, Engineering, Arts, and Mathematics education in secondary schools in which

relevant pedagogies for classroom instruction revisited. They maintain that school teachers should receive professional development training on computational-thinking instructions with modern technology to be able to handle materials that focus on integrating varying instructional practices in the classroom, which yield their self-confidence. Thus, if teachers' self-confidence was not strong it will give negative impact to pedagogy in classroom (Talib, Aliyu, & Zawadzki, 2019). Thus, teacher's self-confidence in computational thinking skills should be nurtured and enhanced in relation to the ability to do mathematical computations, the ability to give instructions, as well as the ability to use computer technologies and software for effective classroom instruction. Thus, this study intended to investigate science teacher's self-confidence on integrating computational thinking into classroom pedagogies for teaching and learning.

Objectives and Research Questions of the Study

The objectives of the study are to:

(a) investigate the extent of teachers' self-confidence on integrating computational thinking into classroom pedagogies for teaching and learning; as well as

(b) find out differences between teachers' self-confidence on computational thinking based on gender.

Thus, the research questions guiding the study are:

- What are the levels of teachers' self-confidence on integrating computational thinking into classroom pedagogies for teaching and learning? and
- Is there any significant difference between teachers' self-confidence on computational thinking based on gender?

On the basis of these questions, the researchers hypothesized that:

> 'There is no significant difference in self-confidence on computational thinking based on gender.'

Methodology

This research employed mainly quantitative methods in data collection and analysis to attain the objectives of study. The following are some of the important issues discussed including sampling, instruments and data collections.

Sampling Techniques

According to Cresswell (2012) and Rafeedalie (n.d.), sampling is part of population as representing the population. In this study, 40 science teachers were randomly selected as a sample of the study and were questionnaire via the Google Form. Only 28 respondents of science teachers gave feedback consisting 9 male teachers and 19 female teachers.

Data Collection and Analysis

The research instrument includes questionnaires consisting of items related to teaching experience, knowledge about computational thinking and confidence level on computational

thinking skills. The four-point Likert scale was used includes 4 — Strongly Agree (SA), 3 – Agree (A), 2 – Disagree (D) and 1 -Strongly Disagree (SD) [Refer Appendix for Science Teachers' Self-confidence on the Computational Thinking (STSCT) Questionnaire]. The data were analysed through descriptive statistic using program Microsoft Office Excel 2016 for Windows 7 to analyse on self-confidence in computational thinking skills.

Results and Discussion

The results of the study consist of teachers' self-confidence on computational thinking based on gender and their specialization in relation to the component in computational thinking skills.

Gender of the Respondents

Figure 1 illustrates the percentage of respondents according to their gender.

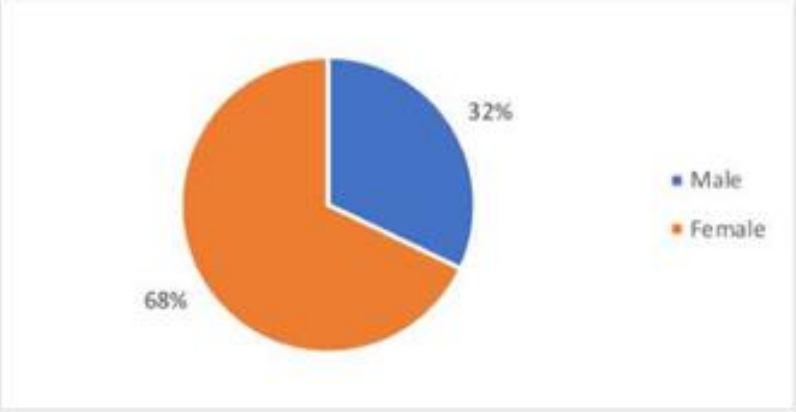

Figure 1. Percentage of respondents according to their gender.

Teaching Experience of the Respondents

Figure 2 summarizes the percentages of the number of years of teaching experience of the science teachers who were the respondents of this study.

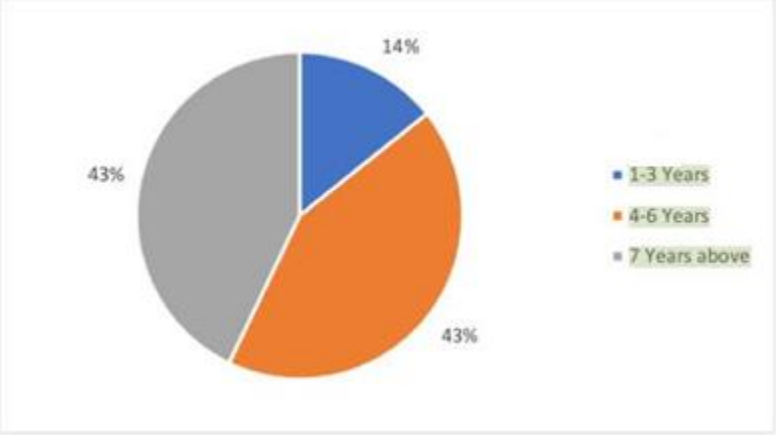

Figure 2. Teaching experience of science teacher.

Research Question 1:

What are the levels of teachers' self-confidence on integrating computational thinking into classroom pedagogies for teaching and learning?

Identifying the science teacher's response on knowledge about computational thinking was conducted before measuring the level of confidence on the science teachers. The analysis of the findings is specifically shown in the following Figure 3. The analysis of data revealed that there were three science teachers who had never heard of the term of computational thinking (CT), 14 science teachers sometimes and 11 always heard of the term CT.

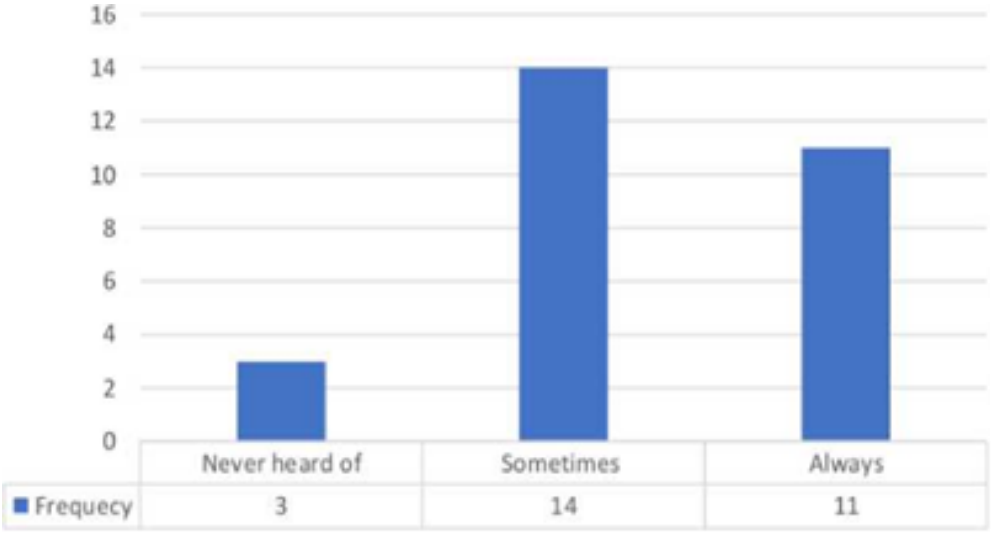

Figure 3. The frequency of response of science teachers about knowledge of computational thinking.

The following Figure 4 revealed that 50% of respondents sometimes heard the term of computational thinking. This result showed that application of computational thinking was not fully used in school. This result is nearly close to the study conducted by Bower, Wood, Lai, Howe, and Lister (2017) which reported that science teachers became aware of the term after attending a workshop a regarding computational practices relating to "problem-solving" activities.

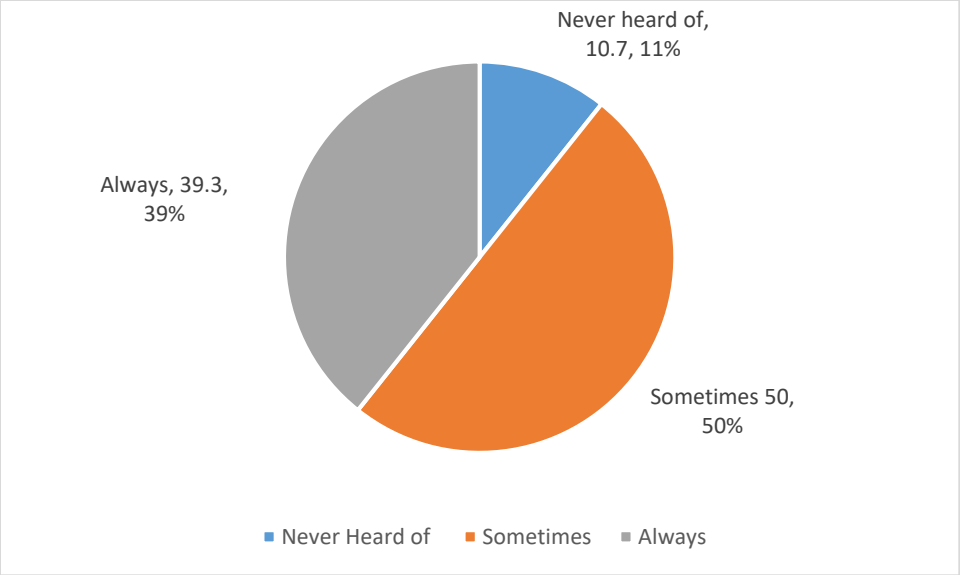

Figure 4. Percentage of science teachers who heard about the term computational thinking.

There is similarity between the abovementioned results and that of the study conducted by Bower, Wood, Lai, Howe, and Lister (2017) in which most teachers did not know the term 'computational thinking' (CT) that is the basic concept in the curriculum of Digital Technology.

However, the result presented in Table 2 indicate that there is high level of teachers' self-confidence on integrating computational thinking into classroom pedagogies for teaching and learning. This was revealed when analysis was made on the teachers' responses towards the items that were classified according to the definitions of computational thinking [Refer Table 1 and Appendix].

For Table 2 No.1, a total of 64.3% of respondents agreed that they like to solve problems in science education. Only a total of 35.7% of respondents strongly agreed that they like solving problem in science education. A total of 67.8% of female respondent more than male 32.2%. This means that science teachers like to solve the problems in their education.

Table 2
Analysis of Responses for Item l to Item 14 in Science Teachers' Self-confidence on the Computational Thinking Survey (STSCT)

S. No.	Items		SA Freq (%)	A Freq (%)	Total
1	I like to solve problems in science education	Male	4 (14.2%)	5 (17.8%)	9 (32.2%)
		Female	6 (21.4%)	13 (46.3%)	19 (67.8%)
		Total	**10 (35.7%)**	**18 (64.3%)**	**28 (100%)**
2	I can achieve good grades in computational thinking skills	Male	8 (28.5%)	1 (3.5%)	9 (32.2%)
		Female	19 (67.8%)	0 (0.0%)	19 (67.8%)
		Total	**27 (96.3%)**	**1 (3.5%)**	**28 (100%)**

3	I am good in using a computer or tablet/iPad in science teaching	Male	7 (25.0%)	2 (7.14%)	9 (32.2%)
		Female	18 (64.2%)	1 (3.57%)	19 (67.8%)
		Total	**25 (89.2%)**	**3 (10.7%)**	**28 (100%)**
4	I am very sure of my ability to use computers for teaching science	Male	8 (28.5%)	1 (3.57%)	9 (32.2%)
		Female	18 (64.2%)	1 (3.57%)	19 (67.8%)
		Total	**26 (92.7%)**	**2 (7.14%)**	**28 (100%)**
5	I am interested in learning about using computer programming in teaching science practice	Male	4 (14.2%)	5 (17.8%)	9 (32.2%)
		Female	5 (17.8%)	14 (50.0%)	19 (67.8%)
		Total	**9 (32.0%)**	**19 (67.8%)**	**28 (100%)**
6	I am sure that I can solve problems in teaching science by using computer applications	Male	8 (28.5%)	1 (3.5%)	9 (32.2%)
		Female	19 (67.8%)	0 (0.0%)	19 (67.8%)
		Total	**27 (96.3%)**	**1 (3.5%)**	**28 (100%)**
7	I like to find a solution in computational science teaching	Male	1 (3.57%)	8 (28.5%)	9 (32.2%)
		Female	3 (10.7%)	16 (57.1%)	19 (67.8%)
		Total	**4 (14.2%)**	**24 (85.6%)**	**28 (100%)**
8	When something is wrong in science, I like to find a solution using computer	Male	3 (10.7%)	6 (21.4%)	9 (32.2%)
		Female	5 (17.8%)	14 (50.0%)	19 (67.8%)
		Total	**8 (28.5%)**	**20 (71.4%)**	**28 (100%)**
9	The challenge of solving problem using computer science appeals to teacher	Male	8 (28.5%)	1 (3.5%)	9 (32.2%)
		Female	19 (67.8%)	0 (0.0%)	19 (67.8%)
		Total	**27 (96.3%)**	**1 (3.5%)**	**28 (100%)**
10	I am good at finding small problems to fix that are part of solving a bigger problem	Male	3 (10.7%)	6 (21.4%)	9 (32.2%)
		Female	9 (32.1%)	10 (35.7%)	19 (67.8%)
		Total	**12 (42.8%)**	**16 (57.1%)**	**28 (100%)**
11	I am good at giving directions to use computer in science subject	Male	9 (32.1%)	0 (0.0%)	9 (32.2%)
		Female	17 (60.7%)	2 (7.14%)	19 (67.8%)
		Total	**26 (92.8%)**	**2 (7.14%)**	**28 (100%)**
12	I am good at following directions in teaching science	Male	9 (32.1%)	0 (0.0%)	9 (32.2%)
		Female	18 (64.2%)	1 (3.5%)	19 (67.8%)
		Total	**27 (96.3%)**	**1 (3.5%)**	**28 (100%)**
13	I think that computer in science teaching is interesting	Male	7 (25.0%)	2 (7.14%)	9 (32.2%)
		Female	6 (21.4%)	13 (46.4%)	19 (67.8%)
		Total	**13 (46.4%)**	**15 (53.5%)**	**28 (100%)**
14	I enjoy working with computers in teaching science	Male	4 (14.2%)	5 (17.8%)	9 (32.2%)
		Female	7 (25.0%)	12 (42.8%)	19 (67.8%)
		Total	**11 (39.2%)**	**18 (60.6%)**	**28 (100%)**

From Table 2 No.2, only 3.5% of total respondents agreed that they can achieve good grades in computational thinking skills. 96.3% of respondents agreed that they can achieve good grades in computational thinking skills. Female respondents' agreement is 67.8% as compared to male

percentage only 28.5%. This mean that generally science teachers believe that they can have good grades in computational thinking skill in education.

As observed in Table 2 No.3, a total of 10.7% respondents agreed that they are good in using a computer, tablet or iPad in science teaching. 89.2% of respondents strongly agreed they are good in using a computer or tablet in science teaching. Female respondents' strong agreement is 64.2% as compared to male percentage only 25.0%. This result mean that science teacher mostly like and have good skill using computer or tablet in science teaching in school.

From Table 2 No.4, 7.14% of respondent agreed and 92.7% of respondent strongly agreed that their ability to use computers for teaching science. Female respondents choose strongly agree (64.2%) which is more than male respondents with only 28.5%. This mean that science teachers believe that they can use computers as tools for teaching science in the classroom.

It can be observed from Table 2 No.5 that 67.8% of respondents agreed and 32.0% choose strongly agreed that they are interested in learning about using computer programming in teaching science practice. There are more percentages of female (17.8%) than male (14.2%) respondents who choose strongly agree. They even do not choose disagree and this mean that almost all science teachers are interested to use computer programming for learning and teaching of science practice in classroom.

From Table 2 No.6, only 3.5% of respondent agreed that they can solve problems in teaching science using computers applications. Meanwhile 96.3% of respondents choose strongly agree in this item with female respondents (67%) more than male (28.5%) in this item. These results showed that science teachers mostly can solve the problems in teaching science by using computer applications.

As seen in Table 2 No.7, 85.6% of respondents agreed and 14.2% strongly agreed that they like to find a solution in computational science teaching. Female respondent (57.1%) agreed more than male (28.5%). These results showed that science teachers like to use computational as a solution for the problem in science education.

It can be observed from Table 2 No.8, a total of 71.4% of respondents agreed and 28.5% strongly agreed that when something went wrong in science, they like to find a solution using computer. Female respondents (50.0%) responded agreed more than male respondents which is 21.4% only. This meant that science teachers like to use computers as a solution for problem in science teaching.

From Table 2 No.9, a total of 3.5% disagreed and 96.3% strongly agreed that the challenge of solving problem using computer science appeals to them. For female respondent, a total of 67.8% strongly agreed more than male 28.5%. These results showed that science teachers like to solve problem as a challenge using computer science.

From Table 2 No.10, a total of 57.1% of respondents agreed and 42.8% strongly agreed that they are good in fixing identified minor problems which may be integral part of solving problems that are complex. Female respondents (35.7%) agreed more than male respondents (21.4%). This meant that science teachers can solve small problem as part of a bigger problem in science teaching using computational thinking skills.

As indicated in Table 2 No.11, a total of 7.14% respondents agreed and 92.8% strongly agreed that they were good at giving directions to use computer in science subject. There were 60.7% of female respondents more than 32.1% of male respondents in this item. These results showed science teachers can give good directions to use computer in science subject.

From Table 2 No.12, a total of 3.5% respondents agreed and 96.3% strongly agreed that they were good at following directions in teaching science. Female respondents (64.2%) more strongly agreed than male respondents (32.1%). This mean that, science teacher mostly have a good at following directions in teaching science.

From Table 2 No.13, a total of 53.5% of respondents agreed and 46.4% strongly agreed that they think of computer in science teaching is interesting. Female respondent (46.4%) agreed more than male respondent (7.14%). This result showed that mostly science teachers were interested in using computers in science teaching.

As indicated in Table 2 No.14, a total of 60.6% of respondents agreed and 39.2% strongly agreed that they enjoy working with computers in teaching science. Female respondents (42.8%) agreed more than male respondents with 17.8% only. This meant that science teachers mostly enjoy using computers in teaching science.

Research Question 2:

Is there any difference between teachers' self-confidence on computational thinking based on gender?

To answer the second research, an independent t-test was conducted to find out the difference between male and female teachers' self-confidence on computational thinking. The results of the analysis are represented in Table 3 and Table 4 respectively.

The following Table 3 showed the mean differences between male and female respondents

Table 3
Mean Difference between Female and Male Respondents

Groups	N	Mean	Std. Deviation	Std. Error Mean
Female	9	3.43	0.17	0.06
Male	19	3.93	0.13	0.03

It can be observed from Table 3 that, female respondents have an average of 3.43 mean score of teachers' self-confidence on computational thinking, whereas male respondents have an average of 3.93 mean score. In both gender, respondents' opinion is higher toward "strongly agree" than "agree". Thus, the different may exist but might not be significant. To determine the significant level of the difference between the genders, Table 4 represents t-test result for the analysis.

As shown in Table 4, the p-value (0.670) is greater than 0.05 which indicated that there is no difference between male and female teachers' self-confidence on integrating computational thinking. The result did not fall within rejection level. Thus, the hypothesis stated "there is no significant difference in self-confidence on computational thinking based on teacher's gender" is accepted.

Table 4
Independent Samples T-Test

		Levene's Test for Equality of Variance		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Mean	Equal variance assumed	0.161	0.692	0.432	26	0.670	0.05302	0.12283	-0.19945	0.30550
	Equal variances not assumed			0.404	13.542	0.692	0.05302	0.13109	-0.22903	0.33507

*$p<0.05$

Conclusion

Summary and Implication

The findings of this study revealed that computational thinking skills have actually been dominated by both male and female science teachers. This result is similar to the finding of Bower, Wood, Lai, Howe, and Lister (2017) who stated that male and female teachers felt the same interest in improving their computational thinking skills. This study also showed findings in line with the literature stating that self-confidence in the computational thinking skill was included in addressing complex problems (Bower, Wood, Lai, Howe, & Lister, 2017). But there were differences based on gender regarding the self-confidence of science teachers on computational thinking skills. This is probably because female science teachers were more than male teachers in this study and most of the female science teachers were interested using computers.

In addition, literature revealed computational thinking skills were introduced in various STEM disciplines (Yadav, 2014). Hence, high confidence levels in the computational thinking skills of science teachers as revealed in this study was probably due to the fact that computational thinking skills were closely related to Science, Technology, Engineering, and Mathematics (STEM) that were emphasised in the Malaysian curriculum in the recent years. The implication of this study is very essential for science teachers since computational thinking skills can help to facilitate solving of problems in everyday life.

Significance and Future Direction

This study contributed to the most significant finding that science teachers are agents in computational thinking skills. Computational thinking skills are considered significant in computer science (Cansu & Cansu, 2019). The skill that is used to be expressed as an algorithmic

thinking in the beginning has expanded in the course of time and become a basic skill where various top-level skills are used together that need to be acquired by everyone. Hence prospective teachers should be able to see that computational thinking skills are connected to various disciplines of their work. In fact, Yadav, Hong, and Stephenson (2016), advocated the need to incorporate computational thinking skills into other content areas at the K-12 level as it is important to sharpen the teacher's knowledge of computational thinking skills.

Hence science teachers need to improve their self-confidence in computational thinking skills by demonstrating confidence of knowledge/skills related to programming in various content areas to promote creativity and problem-solving skills among learners. The results obtained in this study are very important for science teachers and other teachers of various subject disciplines. If given the opportunity to carry out serious training from time to time, science teachers can increase their knowledge about computational thinking skill and improve their self-confidence in computational thinking skills in science teaching. Therefore, the Faculty of Education in tertiary institutions should work with the Federal Government to integrate teaching and learning which involves computational thinking skills and provide direct training to science teachers that aims to increase their confidence of teaching and learning in schools.

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Appendices

Science Teachers' Self-confidence on the Computational Thinking Survey (STSCT)

Part A

This study is to investigate the self-confidence on the computational thinking among Science teacher. Please select one of the following items:

Scale	Items
1	Strongly Disagree
2	Disagree
3	Agree
4	Strongly Agree

	Descriptions	Scale			
	a) Decomposition				
1	I like to solve problems in science education	1	2	3	4
2	I can achieve good grades in computing thinking skills	1	2	3	4
3	I am good at using a computer or tablet/iPad in science teaching	1	2	3	4
	b) **Pattern Recognition**				
4	I am very sure of my ability to use computers for teaching science	1	2	3	4
5	I am interested in learning about using computer programming in teaching science practice	1	2	3	4
6	I am sure that 1 can solve problems in teaching science by using computer applications	1	2	3	4
7	I like to find a solution in computational science teaching	1	2	3	4
	c) Abstractions				
8	When something is wrong in science, 1 like to find a solution using	1	2	3	4
9	The challenge of solving problem using computer science appeals to me	1	2	3	4
10	The challenge of solving problem using computer science appeals to me	1	2	3	4
11	I am good at finding small problems to fix that are part of solving a bigger problem	1	2	3	4
	d) Algorithms				
12	I am good at giving directions to use computer in science subject	1	2	3	4
13	I am good at following directions in teaching science	1	2	3	4
	e) Evaluations				
14	I think that computer in science teaching is interesting	1	2	3	4
15	I enjoy working with computers in teaching science	1	2	3	4