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## Teachers' Concern towards Applying Computational Thinking Skills in Teaching and Learning

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### ABSTRACT

The purpose of this study was to examine the teachers' concern towards applying computational thinking skills in their teaching and learning. This study used Concerns-Based Adoption Model (CBAM) to identify the Stages of Concern (SoC) of the respondents. The questionnaires used were 35 items that were measured using a Likert scale of 7 points. Questionnaires were distributed to all the teachers in a district in Sarawak, Malaysia. A total of 564 responds were collected in this study. The findings indicated that the respondents were at the Unconcerned Stage (Stage 0) with highest percentile score of 94%, followed by Informational Stage (Stage 1) and Management Stage (Stage 3). The findings also indicated that the respondents showed minimal concern but are interested and need more information on how to apply computational thinking skills in teaching and learning. The findings of this study are expected to assist the concern and the ministry to improve the delivery of information concerning computational thinking skills in teaching and learning to the teachers.

**Keywords:** stages of concern, computational thinking, innovation, CBAM, teaching and learning

### INTRODUCTION

Computational thinking (CT) skills have been introduced together with information and communication technology (ICT) skills as one of the steps to improve the existing curriculum in schools in Malaysia. The change to the existing curriculum through the integration of CT skills is based on the current education transformation in line with the global demands (Ministry of Education [MOE] 2016). CT skills have been considered as one of the steps to develop students' ability to solve problems. Through CT skills, students are trained to think rationally and systematically to solve problems using basic principles of computer science. According to Wing (2017), CT is the thought processes involved in formulating a problem and presenting its solution in a method that a computer, human or machine can accomplish. CT describes the practice of thinking in solving problems through computational solutions that include computations, algorithmic thinking, computerization, resolution, deletion and simplification (Angeli et al. 2016; Bocconi et al. 2016). CT can also be

described as a process of thinking where solutions to problems can be designed and assessed by data processing techniques (Mohaghegh & McCauley 2016).

A variety of definitions of CT have been raised by researchers proves that CT can be applied on a large range across many disciplines in addition to in computer science and information science where CT can be used to solve complex problems (Voogt et al. 2015; Yadav et al. 2014). Although there is some dissimilarity related to the definition of CT, most researchers agree that CT is a necessary skill and should be mastered in the 21<sup>st</sup> century (Mohaghegh & McCauley 2016). Thus, recognizing the importance and benefits of CT, it is the duty of teachers to apply CT skills in their teaching and learning activities.

The initiative to include the concept of CT skills in the education system has been highly stressed in some countries. In fact, CT has been considered as 21<sup>st</sup> century literacy by concerned parties in computer science and education (Mohaghegh & McCauley 2016). The biggest global movement of CT and programming is the Hour of Code campaign which participated by 15 million students worldwide during the Computer Science Education Week 2014 (Israel et al. 2014). Hour of Code is an international movement initiated by code.org. The Hour of Code awareness campaign was held throughout Malaysia in October 2017 to November 2017 involving 745 schools and 80037 pupils (MOE 2018) to provide early exposure and increase student's knowledge of coding skills, programming and computer science (MOE 2017). In addition, this campaign has been awarded the "most coding activity" by the Malaysia Book of Records (MBOR).

#### *Concern-Based Adoption Model (CBAM)*

A teacher's concern about innovation is varied depending on the level of knowledge, experience and service of the teacher (George, Hall & Stiegelbauer 2013). A person who never uses the innovation will experience different stages of concern because an innovation needs new knowledge and skills to be learned. To examine the stages of concern over the application of computational thinking skills in teaching and learning, this study uses the Concern-Based Adoption Model (CBAM). CBAM has been recognized by various researchers in which it facilitates us to understand and to classify the stages of teacher's concern for the change (Holloway 2003) from the beginning of the innovation in the education system (Matar 2015) in order to improve the quality of education (Roselita et al. 2017). CBAM is a particularly developed model for assessing the implementation of innovative curriculum or educational programs (Sharifah et al. 2012) and has been applied in numerous studies involving various educational innovations (Wang 2014). This statement is supported by Matar (2015) which states that CBAM is an instrument for screening, calculating, defining, and explaining the progress of change experienced by the teachers when an educational innovation is introduced and implemented.

CBAM classified concerns over the seven stages of concern namely Stage 0 (Unconcerned), Stage 1 (Informational), Stage 2 (Personal), Stage 3 (Management), Stage 4 (Consequence), Stage 5 (Collaboration) and Stage 6 (Refocusing). The stages of concern on "Unconcerned" and "Informational" are the stages of Self-Concern, "Management" is the Task-Concern and "Collaboration" and "Refocusing" are the Impact-Concern. Every individual involved in a new innovation must move from the Self-Concern to the Task-Concern, and then to the Impact-Concern to bring about the success of innovation (Sharifah et al. 2012). The seven stages of concern for innovation are as in the following table.

*Stages of Concern About an Innovation. Source: Adaptation from George, Hall and Stiegelbauer (2013) page 8.*

Impact	6 Refocusing	Teachers focus on exploring other benefits of the applying CT skills in their teaching and learning as well as the opportunity of making or replacing them with more effective alternatives.
	5 Collaboration	Teachers focus on collaboration with other teachers in applying CT skills in their teaching and learning.
	4 Consequence	Teachers focus on the impact of applying CT skills in teaching and learning on students and changes needed to improve student outcomes.
Task	3 Management	Teachers focus on processes and tasks of applying CT skills in teaching and learning and the best use of information and resources. Preferred issues are more relevant to efficiency, management, preparation and scheduling.
Self	2 Personal	Teachers have anxieties about their role and ability in applying CT skills in teaching and learning. Teachers are concerned about the impact of applying CT skills in teaching and learning on themselves and their existing commitments including the implications for themselves and colleagues.
	1 Informational	Teachers are well aware of applying CT skills in their teaching and learning and are interested in learning more about the innovations.
	0 Unconcerned	Teachers are less concerned about or less involved in applying CT skills in teaching and learning.

CBAM has three dimensions of diagnostic components namely Stages of Concern, Levels of Use and Innovation Configurations (Loucks 1983). However, this study will only review the stages of concern using the Stages of Concern dimension. This dimension is a framework for measuring the implementation of changes that occur in schools among teachers. By identifying the stages of concern, researchers may identify the future needs to help the teachers to be able to apply CT skills in their teaching and learning.

### PROBLEM STATEMENT

Understanding the stages of teachers' concern towards applying CT skills in their teaching routines is necessary to make sure that it is successfully implemented. However, examining the stages of concern for an innovation in education is not easy (Hall et al. 1973). A teacher may apply the CT skills in his teaching and learning activities while his colleagues may choose not to apply. There is a level of progress in applying CT skills in education system that every teacher needs to go through to allow it to precede with effectiveness. If the teacher is not concerned, then the process of applying the CT skills to the students may fail. Indirectly, the ministry's aim to include CT skills in teaching and learning activities in schools may not succeed. The stages of concern for a teacher are also closely related to

their work quality. This statement is supported by Sultana (2015) which stated an individual's concern for an innovation directly related to their quality of work.

There are various efforts to improve our understanding on CT, but there are challenges to overcome, particularly in applying CT skills in schools (Wientrop et al. 2015). These challenges include defining the learning progress and the curriculum involved, accessing and evaluating student progress, and preparing the teachers with sufficient skills to carry out the innovation (Grover & Pea 2013). Thus, preparing the teachers to be able to apply CT skills in their teaching and learning is not an easy task.

CT is one of the 21<sup>st</sup> century skills that should be given attention in education. According to Voogt et al. (2015), although CT is no longer new, but studies related to the application of CT skills in education are still deficient. Hence, there is an urgent need to conduct a study to examine the stage of teachers' concern towards applying CT skills in teaching and learning.

## **METHODOLOGY**

This is a quantitative study using a survey study method, where the researchers administered a questionnaire to a sample on the attitude, opinion, behaviour and characteristics of the population (Creswell 2012). In this study, questionnaires were distributed to all the teachers in a district in Sarawak, Malaysia. Data was collected using a questionnaire adapted from the CBAM - The Stages of Concern Questionnaire (SoCQ) in Tan & Lee's (2015) study. SoCQ is a quantitative instrument that measures the feelings of teachers or users toward an innovation (George, Hall and Stiegelbauer 2013). The questionnaire used is consists of 35 items that were measured using the Likert scale of 7 points. Respondents would mark each item on a scale of 0 - 7 based on the accuracy of the item on themselves regarding their concern towards applying CT skills in teaching and learning. There are five statements in each stage. The stages of concern are then grouped according to the seven stages of concern as suggested in the CBAM. The data of this study were analyzed based on the Measuring Implementation in Schools guide: The Stages of Concern Questionnaire by George, Hall and Stiegelbauer (2013). The following section will present the results and discussion of stages of concern based on demographic data collected.

## **RESULTS AND DISCUSSION**

A total of 564 responds are collected in this study. 411 (72.87%) respondents are female and 153 (27.13%) are male. 243 (43.09%) respondents are aged between 30 and 39 and 38 (6.74%) respondents are age 20 – 29. 460 (81.56%) respondents are graduate and 30 (5.32%) are post graduate. 189 (33.51%) of the respondents are with 11 to 20 years of teaching experience and 35 (6.21%) are with 31 years and above of teaching experience. 280 (49.65%) of the respondents never attend any CT skills course or training. Detailed demographic background of the respondents are divided into gender, age, academic qualifications, teaching experience and number of times attending CT skills course or training as in Table 1.

*Table 1*  
*Demographic Background of Respondents*

Variables	Demography	Frequency N = 564	Percentage (%)
Gender	Male	153	27.13
	Female	411	72.87
Age (years old)	20 – 29	38	6.74
	30 – 39	243	43.09
	40 – 49	198	35.11
	50 and above	85	15.07
Academic qualification	Non Graduate	74	13.12
	Graduate	460	81.56
	Post Graduate	30	5.32
Teaching experience (years)	1 – 10	184	32.62
	11 – 20	189	33.51
	21 – 30	156	27.66
	31 and above	35	6.21
Number of times attending CT skills course or training	Never	280	49.65
	1 time	125	22.16
	2 times	51	9.04
	3 times and above	108	19.15

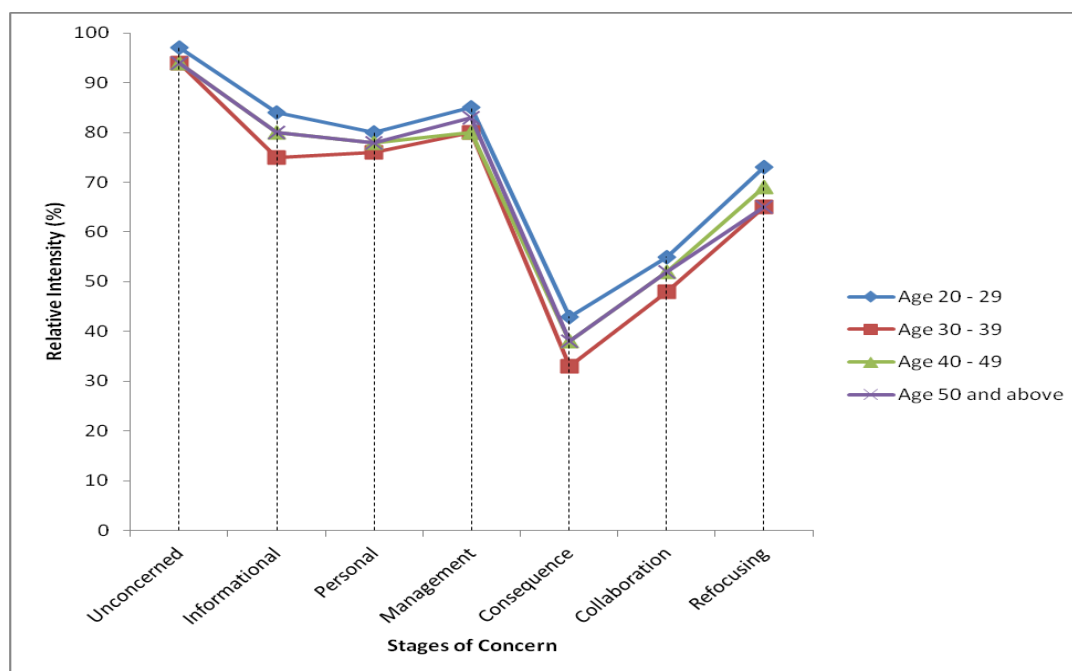
*1) Stages of Concern toward Application of Computational Thinking Skills in Teaching and Learning Based on Age Group*

The stages of concern for all age groups show the highest score at Stage 0 (Unconcerned). According to George, Hall & Stiegelbauer (2013), the high score of Stage 0 shows that respondents are not only concerned about the application of CT skills in teaching and learning, but there are other tasks and activities they pay attention to. The findings also show the second highest score for each age group is at Stage 3 (Management). The second highest percentage score in Stage 3 shows that the respondents are concerned about time or other management of the innovation. In other words, respondents are concerned about the aspects of management and the time to be taken for this innovation (George, Hall & Stiegelbauer 2013). The score for the group 20 -29, 40 – 49 and 50 and above show the Stage 1 score higher than the Stage 2 score. This shows that teachers in these groups are likely to have positive and proactive perspective and are slightly worried about the impact of this innovation on their personal. This is a “positive one-two split”. It also shows that teachers in these groups are open and interested in learning more about the application of CT skills in teaching and learning. Stage 4 (Consequence) shows the lowest score for each age group as shown in Figure 1. Low intensity at Stage 4 shows that respondents are less



concerned about the effect of the application of CT skills in teaching and learning to their students. The percentage score based on age groups are shown in Table 2 as follows.

*Figure 1*  
*Teachers' Stages of Concern toward Application of Computational Thinking Skills Based on Age Group*



*Table 2*  
*Stages of Concern Percentage Score Based on Age Group*

Age Group	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Age 20 - 29	97	84	80	85	43	55	73
Age 30 - 39	94	75	76	80	33	48	65
Age 40 - 49	94	80	78	80	38	52	69
Age 50 and above	94	80	78	83	38	52	65

2) *Stages of Concern toward Application of Computational Thinking Skills in Teaching and Learning Based on Academic Qualification Group*

The stages of concern for all academic qualification groups showed the highest score at Stage 0 (Unconcerned). The higher the Stage 0 score indicated other things, innovations or activities are of greater concern that the innovation under consideration (George, Hall & Stiegelbauer 2013).

Second highest score for all groups score at Stage 3 (Management) indicates the respondents have intense Management concerns but also have strong ideas about how the change process should be different. The findings show that the Stage 2 score is higher than Stage 1 score for Non-Graduate group as in Figure 2. This is a “negative one-two split”. This shows that respondents are with various degrees of doubt and potential resistance to an innovation. The teachers in this group are more concerns about an innovation’s effect on personal position rather than the desire to learn more about the innovation. A teacher with this score probably will not be able to consider a proposed innovation objectively until their personal Stage 2 concerns are reduced. The lowest score for all academic qualification groups are at Stage 4 which indicates all respondents are less concerned about the consequence of application of CT skills toward their students. The percentage score based on academic qualification groups are shown in Table 3.

Figure 2

*Teachers’ Stages of Concern toward Application of Computational Thinking Skills Based on Academic Qualification Group*

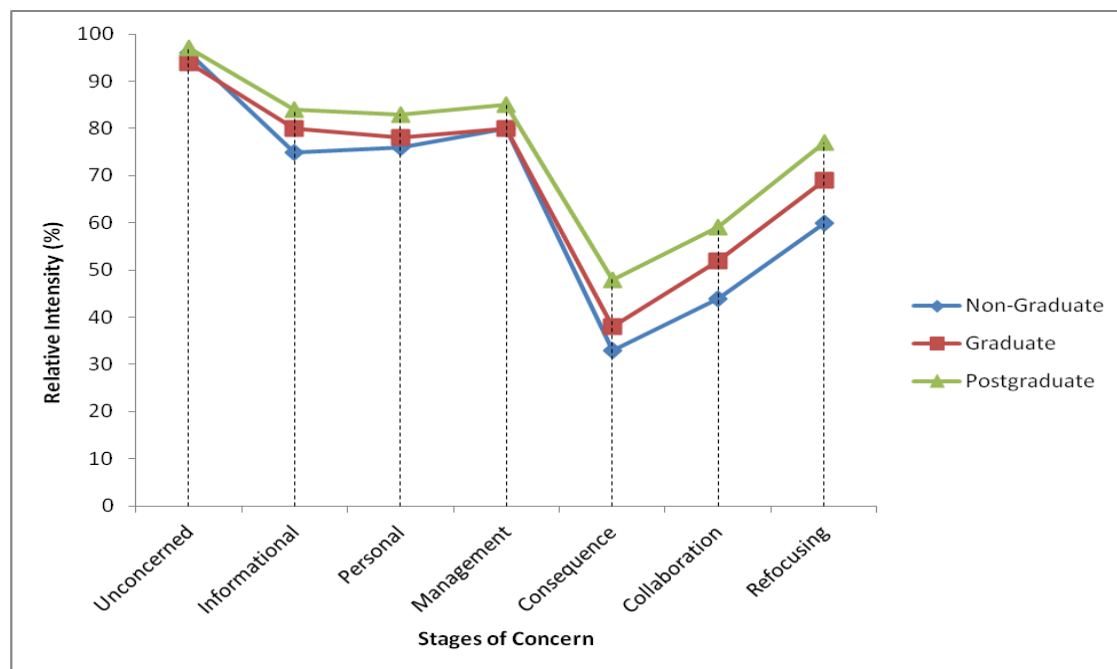


Table 3

*Stages of Concern Percentage Score Based on Academic Qualification Group*

Academic Qualification Group	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Non-Graduate	96	75	76	80	33	44	60
Graduate	94	80	78	80	38	52	69
Postgraduate	97	84	83	85	48	59	77

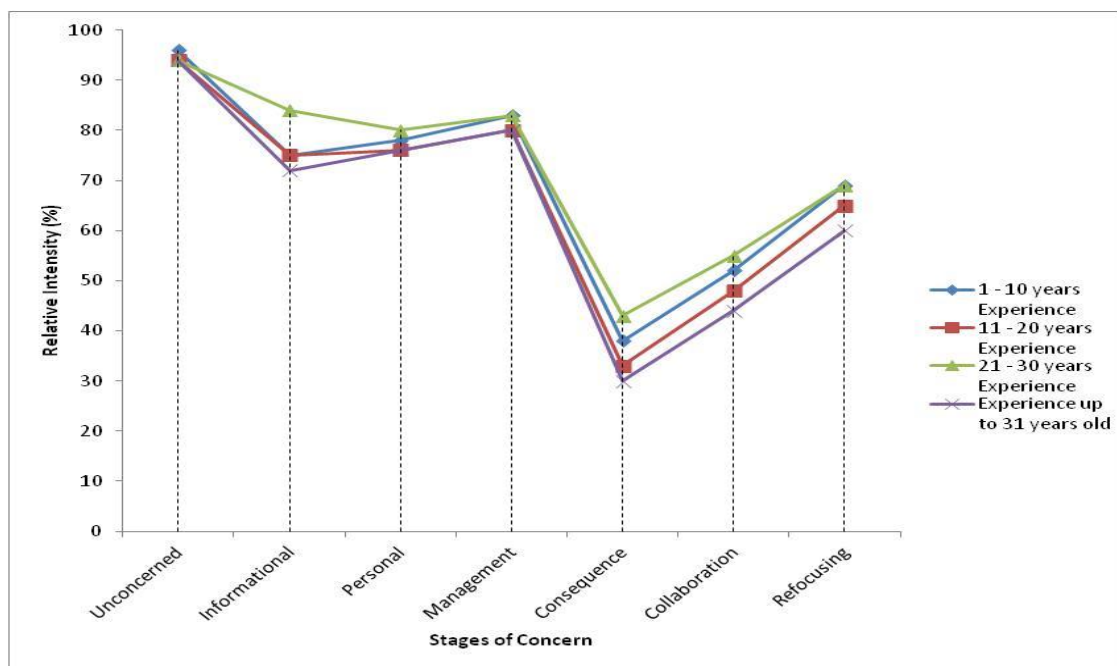


### 3) Stages of Concern toward Application of Computational Thinking Skills in Teaching and Learning Based on Teaching Experience Group

The stage of concern for 1 – 10 years teaching experience group score the highest among all groups at Stage 0 (Unconcerned). A high Stage 0 indicates the respondents are not concerned about the innovation. The findings show the second highest for group 1 – 10, 11 – 20 and 31 years and above teaching experience are at Stage 3 (Management). The high Stage 3 indicates their concerns about logistics, time, and management. These three groups also show the “negative one-two split” which depicts the respondents in these groups probably more negative toward the application of CT skills in teaching and learning and generally are not open to information about the innovation. In contrast, the second highest for group 21 – 30 years of teaching experience is at Stage 1 (Informational). This indicates the respondents in this group want more information about the innovation. In addition, this group also show the “positive one-two split” where the score of Stage 1 (Informational) is higher than Stage 2 (Personal) as in Figure 3. This also indicates that respondents in this group are interested and need more information about the innovation (George, Hall & Stiegelbauer 2013). The tailing-up of Stage 6 (Refocusing) for all groups signify the respondents have the ideas that he or she sees as having more other important things than the innovation. In addition, the tailing-up of the Stage 6 concerns could be a warning that the respondents might be resistant to the innovation. The percentage score based on teaching experience groups are shown in Table 4.

Figure 3

*Teachers' Stages of Concern toward Application of Computational Thinking Skills Based on Teaching Experience Group*



*Table 4*  
*Stages of Concern Percentage Score Based on Teaching Experience Group*

Teaching Experience Group	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
1 - 10 years Experience	96	75	78	83	38	52	69
11 - 20 years Experience	94	75	76	80	33	48	65
21 - 30 years Experience	94	84	80	83	43	55	69
Experience up to 31 years	94	72	76	80	30	44	60

4) *Stages of Concern toward Application of Computational Thinking Skills in Teaching and Learning Based on Number of Times Attending CT Skills Course or Training Group*

The stages of concern for all number of times attending CT skills course or training groups show the lowest score at Stage 4 (Consequence). This suggests that the respondents have minimal concerns about the effects of the innovation on students. The percentage score of Stage 1 (Informational) is higher than Stage 2 (Personal) for the respondents who attend CT skills course or training 2 times and 3 times and above. That is a “positive one-two split”. This shows that the respondents in these two groups are open to and interested in learning more about the innovation (George, Hall & Stiegelbauer 2013). The teachers in these groups probably have a positive and proactive perspective toward the application of CT skills in teaching and learning. In contrast, the never attend and only 1 time attend groups score the same percentage for both their Stage 1 and Stage 2. The stages of concern for all groups score the highest at Stage 0 (Unconcerned) as in Figure 4. Stage 0 scores indicate the degree of interest in the innovation. The findings show the second highest for all groups are at Stage 3 (Management). The high Stage 3 indicates a high level of concern about time, logistics, or other managerial problems related to the innovation. The percentage score based on number of times attending CT skills course or training groups are shown in Table 5.

Figure 4

*Teachers' Stages of Concern toward Application of Computational Thinking Skills Based on Number of Times Attending CT Skills Course or Training Group*

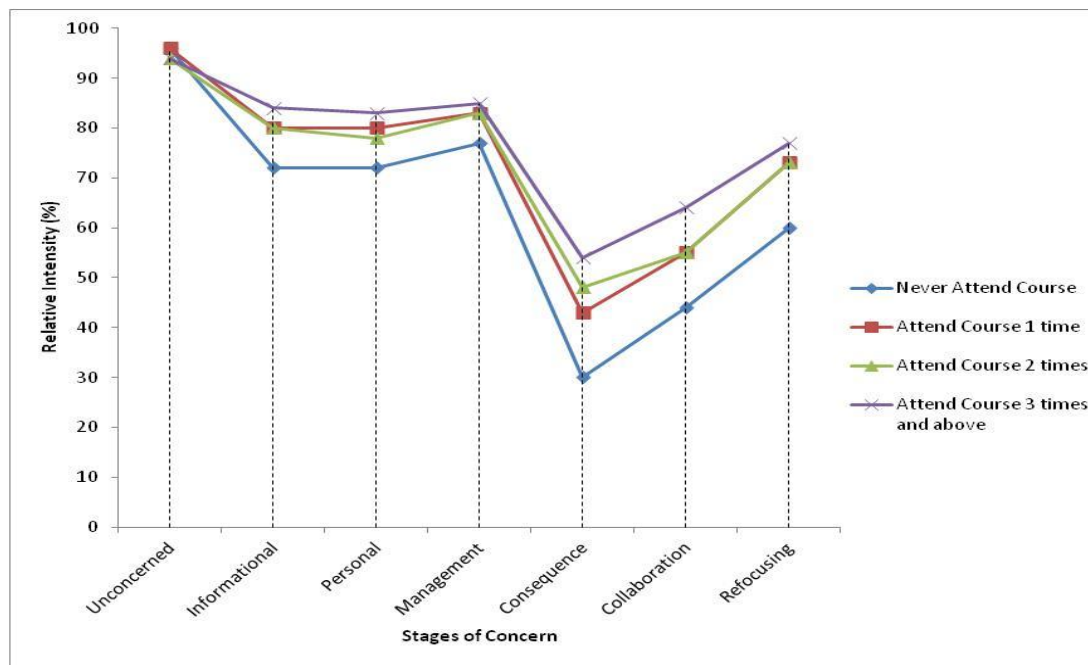


Table 5

*Stages of Concern Percentage Score Based on Number of Times Attending CT Skills Course or Training Group*

Number of Times Attending CT Skills Course or Training Group	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Never Attend Course	96	72	72	77	30	44	60
Attend Course 1 time	96	80	80	83	43	55	73
Attend Course 2 times	94	80	78	83	48	55	73
Attend Course 3 times and above	94	84	83	85	54	64	77

5) *Teachers' Stages of Concern toward Application of Computational Thinking Skills in Teaching and Learning in General*

The stage of concern toward application of computational thinking skills in teaching and learning in general score the highest at Stage 0 (Unconcerned). The highest point indicates the most intense concern of the respondents (George, Hall & Stiegelbauer 2013). As we assume the respondents would interpret these items in the same way as nonusers, Stage 0 score could signifies the degree of priority the respondents are placing on innovation and the relative intensity of concern about the innovation. A high Stage 0 indicates that there are a number of

other initiatives, tasks, and activities that are of concern to the respondents. Although the score are highest at Stage 0, the relative position of Stages 1 (Informational) and Stage 2 (Personal) are more important to understand the characteristic in the respondents. The percentage score of Stage 1 is higher than Stage 2 and depict a “positive one-two split”. This suggests that the respondents are interested and need further information about the innovation. Second highest score are at Stage 1 (Informational) and Stage 3 (Management). A high score at Stage 3 indicates concerns about logistics, time and management related to the innovation. Meanwhile, the lowest score for all the respondents in general scores at Stage 4 (Consequence) as in Figure 5. A low Stage 4 and Stage 5 (Collaboration) scores suggest that the respondents have minimal concerns about the effect of application of CT skills on their student and they are not concerned about working with others. The Stage 6 (Refocusing) tailing-up suggest the respondents have strong ideas about how to do things differently. These ideas may be positive, but it could be a warning that the respondent might be resistant to the innovation. A concise display of the distribution of peak stage scores are as in Table 6.

*Figure 5*

*Teachers’ Stages of Concern toward Application of Computational Thinking Skills in Teaching and Learning in General*

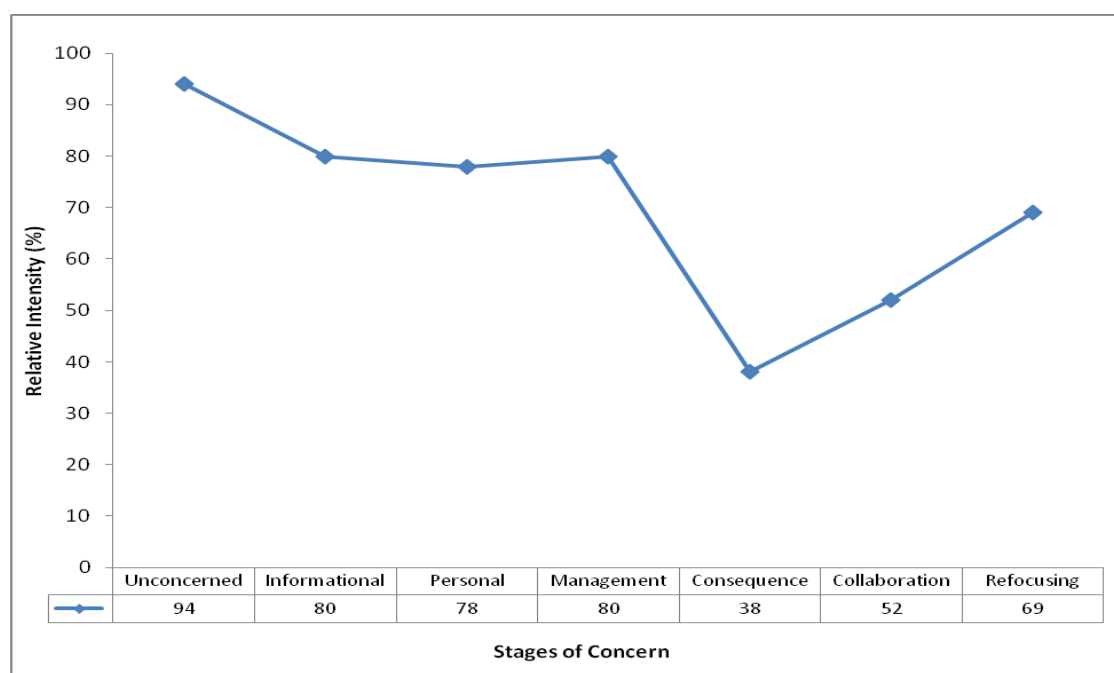


Table 6  
*Frequency of Highest Concerns Stage for Individuals*

Stages of Concern	Number of Teachers	Percent of Teachers (%)
Stage 0	409	72.52
Stage 1	67	11.88
Stage 2	27	4.79
Stage 3	45	7.98
Stage 4	2	0.35
Stage 5	2	0.35
Stage 6	12	2.13
TOTAL	564	100.00

## CONCLUSION

In this study, the findings have shown that the respondents were at the Unconcerned Stage followed by Informational and Management Stage. This indicated that the respondents showed minimal concern but are interested and need more information on how to apply CT skills in their teaching and learning. CT is considered a common proficiency, which should be added to each child's logical capability as an essential element of their school education (Voogt et al. 2015). As shown in this study however, there is still a lot of work to be done to make sure CT skills are applied in schools. The findings of this study are expected to assist the concern and the ministry to improve the delivery of information concerning CT skills in teaching and learning to the teachers. Future studies could be done in examining difference level of use in primary and secondary school.

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