Preliminary Investigation: Teachers' Perception on Computational Thinking Concepts

Ung L. Ling[1], Tammie C. Saibin[1], Jane Labadin[2] and Norazila Abdul Aziz[2]
[1]*Faculty of Computer and Mathematical Sciences, University of Technology MARA (UiTM), 88999 Kota Kinabalu, Sabah, Malaysia.*
[2]*Institute of Social Informatics and Technological Innovations (ISITI), University of Sarawak Malaysia (UNIMAS), 94300 Kota Samarahan, Sarawak, Malaysia.*
ungli720@sabah.uitm.edu.my

***Abstract*—As Computational Thinking (CT) is to be integrated into Malaysian syllabus by the year of 2017, this study therefore is designed to explore Malaysian teachers' perception on CT. A survey method is employed; questions were constructed based on the Technology Acceptance Model (TAM) to acquire teachers' perception on CT. 159 teachers from all over Malaysia completed the survey form. Spearman's Rank Order correlation was implemented on the obtained data. This study managed to present teachers perception on CT via perceived usefulness of CT, perceived ease of CT integration into teaching and learning practices, teachers' attitude towards CT and their intention to integrate CT into their classroom, their basic understanding on CT and their concern on CT integration. Our investigation shows teachers had a weak understanding of CT, which led to unnecessary concerns related to the CT integration. The results also show strong positive correlation on perceived ease of CT integration with behavioral intention and teachers' attitude with behavioral intention.**

***Index Terms*—Computational Thinking (CT); Primary School Teachers; Teaching and Learning (TL); Teachers' Perception.**

I. INTRODUCTION

Computational thinking (CT) skill has seen by many as a must have skill to live and work in today's challenging world. It is defined by Cuny [1] and Jeanette [2] as "the thought of processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent". Wing [2] stressed that CT is as important as reading, writing and counting and it should be included as part of school curriculum. And this is supported by researchers' reports proving that CT managed to alleviate one's higher order thinking skills and improve problem-solving skills [3-6]. Experiments proved that learners scored better not only in computing lessons, but also in mathematics, languages and sciences compared to those who are not [7-9]. However, the adaptation of CT concepts and the delivery of it by teachers to their everyday school practices are not going to be easy [10] and it will require thorough study, to seek and determine the most effective ways of teaching and learning CT, in supporting of teaching and learning skills is highly required, to assist teachers in this attempt of delivering CT in their classroom [11].

Realizing the importance of CT skills, Malaysia Ministry of Education has embarked into the journey to integrate CT concepts into the existing standard curriculum. The newly improved syllabus is able to introduce basic computing skill and also integrated with problem solving, logical thinking and life-long learning skills [12]. For example, CT concepts such as logical thinking, evaluation, algorithm design, and abstraction are considered and embedded in Malaysian improved curriculum via all subjects starts from primary 1 level to high school level [13, 14]. However, is Malaysia ready for it?

This research is designed to investigate Malaysian primary school teachers' understanding and their perception towards CT concepts. It is carried out by adopting TAM model question constructs, namely based on the teachers' perceived usefulness of CT, perceived ease of integration of CT into TL practices, attitude towards CT and behavioral intention to integrate CT into their TL practices. This study gained a better understanding on issues faced by the teachers and it can be a platform leading to better effort in improving CT TL strategy for Malaysian teachers.

II. BACKGROUND OF STUDY

A. Computing in Malaysia

For many years, children's learning concentrated on literacy and mathematics [15, 16]. Attention then shifted to science and technology, integrating technologies into classrooms [17, 18]. As technologies evolve, the technology literacy of young children has varied, questioning the relevancy of the existing science and technology curricula to their development [19, 20]. Researchers suggested that the existing lesson is molding our children as a user of technology, knowing how to use the technologies. However, they do not understand the development, therefore handicap their capabilities in thinking, learning and creating [21-23]. Therefore, children should engage in designing and creating technologies [24], solving problems and able to explore interdisciplinary skills and knowledge [7, 25].

Malaysian children are formally introduced to computer lessons in standard one [26]. The main objective of the lessons is to expose learners to the functions available in the applications. They are taught with basic computer knowledge and applications [27-29].

The situation changes when the Prime Minister of Malaysia announced the integration of CT skills into all subjects, starting in 2017 with Primary 1 and Form 1 students [30]. With this announcement, there is an urgent need to equip the schools, especially the teachers on the teaching & learning (TL) of CT skills in their daily lessons. The newly revised curriculums described the revised curriculum has accounted for improved content based on global trends and international

benchmarking [31]. The teaching and learning pedagogy will concentrate on learning in depth, contextually and effectively; and the development of student learning is assessed based on an on-going basis, with tests in the mid of the semester or at the end of the semester [31]. CT is listed as one of the added components in the revised Malaysian curriculum [12, 13]. The first step of the integration of the CT in the curriculum is by preparing the teachers to deliver the CT concepts in their daily teaching and learning (TL) practices. Workshops are organized to raise teachers understanding on the improved curriculum, preparing them with TL approaches that can be practiced [30]. Therefore, this research is designed with the objectives to determine teachers understanding, their perceptions on CT and to investigate their main concern on the revised curriculum.

B. Computational Thinking (CT)

Association of Computing Machinery (ACM) K-12 Computer Science Curriculum is used in US, introducing CT to learners as young as in kindergarten level. [32] defined CT as a tool allowing people across all disciplines to envision new problem-solving strategies and to test new solutions in both virtual and real world.

According to [33], CT shares the same skills components as computer science such as the algorithmic thinking, conditional logics and modeling. Meanwhile, CT is not about computer programming [2, 34, 35]. CT is becoming an essential skill for everyone [33, 36], as it is believed as a surviving skill and will be rewarding in career undertaking. Following this, researchers have been actively investigating the impact of CT curriculum on teachers' teaching and learning (TL) processes [37, 38], learners' learning outcome [39, 40], instructional tools for CT skills [4, 41], motivation and challenges of integrating CT in classrooms [42, 43].

Most of the studies concentrated on the TL pedagogy and instructional tools. For example, in [44] work, tangible robotic is used as a tool to deliver CT concepts to the young learners, as young as 4 to 6 years old. [45-47] make used of computer programming for TL of CT concepts. While in [37, 38] works, pedagogy of TL were investigated whereby CT concepts were incorporated into as one of the existing syllabus, as problem-solving and critical thinking elements. [48] proposed a feasible model to integrate CT concepts into undergraduate general curriculum. From the review, there is a need to formulate TL pedagogy for Malaysian teachers to deliver CT concepts into their daily classroom. This is important to ensure effective TL processes, and to optimize teachers' roles in their TL practices.

C. Technology Acceptance Model (TAM)

TAM is a model to anticipate the perception and the acceptance level of a new technology introduction to a group of users. TAM is not only applied in investigating the relationship between potential users with tangible technology, but also between users with technological skills and experiences [49]. In recent research by [50] has applied TAM in understanding the relationship of human and technology via intangible set such of Information Literacy skills. TAM is also popular among researchers because of its ability that has always managed to give an idea of perception, the level of acceptance and attitude of potential practitioners. TAM was introduced by [51] in 1989, to predict the users' response towards technology based on two factors, namely the Perceived Usefulness (PU) and Perceived Ease of Use (PEU). There is evidence that TAM is recently popularly used in the research of education [52-54], to acquire different users' perspective in different technologies. This study adopted TAM questions construct to investigate teachers' perception on CT, via the degree of teachers believe in CT benefits and effort required to integrate it in their teaching and learning practices [51, 55, 56].

III. METHODOLOGY

The following research questions guided this study:

i. Do the teachers understand computational thinking (CT) concept?
ii. What is their perception on integrating CT into their teaching and learning (TL) practices?
iii. What do the teachers concern regarding CT?

Before the experiments were conducted, permissions were obtained from the Ministry of Education (MOE), the State Education Department (*Jabatan Pendidikan Negeri*) and also the principals of the schools. 41 primary schools from different states of Malaysia (Sabah, Sarawak, Johor, Selangor, Kelantan, Pahang, Melaka and Kedah) were randomly picked for this study. Depending on the location and the school's infrastructure condition, survey forms were distributed via postage or by email. If the schools are fully equipped with internet connection, emails were sent together with the link to the online survey form. Survey forms were posted using courier (*PosLaju*) if the school do not have full access to the internet connection. 159 teachers have volunteered and answered the survey forms.

The questionnaire is divided into three parts. In the first part of the survey form, in order to acquire teachers' understanding on CT concepts, we used five questions to assess respondents' understanding on computer programming, CT and computer, which were adapted from [38] and [57]. The questions are:

i. I have attended workshop/training/seminar/classes related to computer programming.
ii. I have attended workshop/training/seminar/classes related to CT.
iii. I have attended workshop/training/seminar/classes related to computer.
iv. I understand the concept of CT.
v. Please describe your understanding on CT.

The second part of the survey is designed and managed to acquire to the extent which TAM describes the perception of the Malaysian teachers regarding CT, and to determine their intention to adopt CT and integrate CT skill in their TL practices. However, one item construct is modified to tailor to this study as the research is looking into teachers' technology per skill, whereby CT is assumed as the newly introduced technology. The questionnaire is designed to address the issues on how teachers may come to accept CT and integrate it in their teaching and learning practices. Figure 2 shows the research model for this study. To acquire teachers' perception on the integration of CT into Malaysian syllabus, 5 Likert-type scale questions in the survey form are adapted and modified based on multiple resources [37, 38, 54, 57-59], to acquire the perceived usefulness of CT concepts, perceived ease of integration (CT concepts into TL practices), attitudes towards the improved curriculum and behavioural intention to implement it.

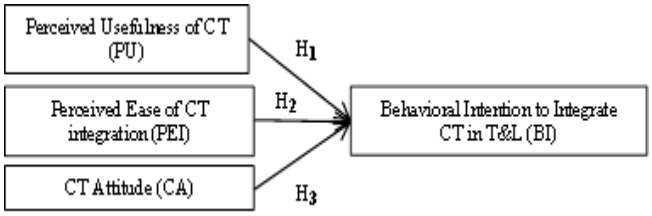

Figure 1: Research model of this study

The present study proposes the following hypothesis:

H_1: The teachers' perceived usefulness (PU) of CT will significantly influence their behavioral intention (BI) in integrating CT in their TL.

H_2: Perceived ease of CT integration (PEI) will significantly influence teacher's behavioral intention (BI) in integrating CT in their TL.

H_3: The teachers' attitude towards CT (CA) will significantly influence teacher's behavioral intention (BI) in integrating CT in their TL.

This part of the survey was composed of 3 items to construct Perceived Usefulness (PU), PEI (Perceived Ease of Integration)-3 items, CA (Teachers' Attitude towards CT)-2 items and BI (Behavioral Intention to Integrate CT in TL)-2 items. Respondents will rate their opinions responding to each statement on a 5-point Likert scale, ranging from Strongly Disagree to Strongly Agree. The items are shown in Table 1.

The obtained data then was analyzed using Cronbach's alpha and Spearman rank order correlation using SPSS version 22. Cronbach's alpha was applied to measure the strength of the correlation between the questionnaire items within each construct as a group [60]. [61] provided guidance in the interpretation of the reliability coefficient by stating that a value of .70 is sufficient for early stages of a research. While Spearman's Rank Order correlation was used to analyze how well the relationship between two variables, as in this study the relationship between PU → BI, PEI → BI and CA→BI.

In order to acquire teachers' concern on CT integration in their TL practices, the third part of the survey form was designed with 2 questions; a question with answer options provided, and the respondents may select more than one answer. Second question is an open-ended question, to allow the respondents to elaborate more on their concern, or even to state other concerns.

Table 1
List of Constructs and Corresponding Items

Construct		Item
Perceived Usefulness of CT	PU1	CT skills is indispensable in everyday life
	PU2	CT involves problem-solving skills.
	PU3	CT skills may benefit one's career achievement
Perceived Ease of CT Integration in TL	PEI1	Extra components CT in the curriculum will not disrupt the process of teaching and learning (TL)
	PEI2	CT components in the curriculum will not increase the workload on me.
	PEI3	Integration of CT in the curriculum does not affect the time spent on the preparation and the process of TL.
Behavioral Intention	BI1	I am interested to know more about CT.
	BI2	I plan to be involved in any process of TL of CT.
Teachers' attitude towards CT	CA1	I am willing to learn any instrument / methods / new technologies that are required for the TL of CT.
	CA2	I like the integration of CT concept in the newly designed syllabus.

Table 2
Demographics information of respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	40	25.2	25.2	25.2
	Female	119	74.8	74.8	100.0
	Total	159	100.0	100.0	

Table 3
Education level

		Frequency	Percent
Valid	Teaching Certificate	11	6.9
	Diploma	27	17.0
	Degree	118	74.2
	Others	3	1.9

IV. RESULT

A. Respondents' Demographic

This study included 159 teachers (40 male and 119 female) from different primary schools in Malaysia. The demographics of the respondents are depicted in Table 2 and Table 3.

In Table 3, indicated 74% of the teachers are Degree holders, 17% Diploma holders, while the remaining respondents have their education certificate, and other relevant qualifications.

B. Do teachers understand CT concept? Awareness of Computational Thinking (CT)

Table 4(a) shows 79.2% of the respondents have not attended any classes/training regarding computer programming. Table 4(b) depicted 83.6% respondents have not attended any training related to CT. Furthermore, 54.7% (Table 4(c)) of the respondents have not even received any formal education on computer.

Table 4(a)
Percentage of respondents attended any computer programming related training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never attended	126	79.2	79.2	79.2
	Attended	33	20.8	20.8	100.0
	Total	159	100.0	100.0	

Table 4(b)
Percentage of respondents attended any CT related training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never attended	133	83.6	83.6	83.6
	Attended	26	16.4	16.4	100.0
	Total	159	100.0	100.0	

Table 4(c)
Percentage of respondents attended computer related training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never attended	87	54.7	54.7	54.7
	Attended	72	45.3	45.3	100.0
	Total	159	100.0	100.0	

Table 5 depicted teachers' understanding level on CT concepts. 31.4% stated that they are ignorant about CT concept, while 54% out of 159 of the respondents with mean of 3.16 responded that they are not sure with the concept. Nevertheless, 13.8% of the respondents have implied that they are aware and understand CT concepts.

Table 5
Summary of respondents' understanding level on CT concepts

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	4	2.5	2.5	2.5
	Disagree	46	28.9	28.9	31.4
	Not Sure	87	54.7	54.7	86.1
	Agree	15	9.4	9.4	95.5
	Strongly Agree	7	4.4	4.4	100.0
	Total	159	100.0	100.0	
Mean			3.16		

There are 26 respondents who have spent time to describe about CT. Table 6 summarizes the responses into categories based on its usage in the answers given by the respondents. They are categorized based on the main keywords mentioned in the answers. The result suggests that most of the participants have described CT as "teaching and learning based on ICT and computer usage, making use of ICT as a tool in enhancing teaching and learning practices; for example, the use of computer in conducting classes or the use of computer in processing students' records. 23% defined CT as making use of computer to complete a task or to solve a problem. Some respondents could form a simple understanding, stating CT involved processes of problem-solving or a process of thought in solving or completing a task. There are respondents had related CT with mathematical thinking, with scientific skill and with humanities field. 3 respondents described CT as computer literacy. A few teachers associated CT with higher-order thinking skill (HOTS). One respondent described CT as solving problem via structuring it into smaller segments which may refer to one of the CT skill component decomposition.

Table 6
Summary of teachers' description on CT

Respondents answer	Hit
Problem solving using mathematical, scientific or problem solving skills	3
Teaching & learning based on ICT & computer usage	6
Using computer to complete a task or to solve a problem	6
Higher order thinking skills	3
A process of solving problem	4
Problem solving based on information processing	1
Computer literacy	3
Solving problem by segmenting the problem into smaller segments	1

C. What is their perception on integrating CT into their teaching and learning (TL) practices)

To investigate teachers' perception on the CT, the statistical analysis is conducted in 2 stages, namely to examine the descriptive statistic of the measured items by assessing the reliability and validity of the items, and followed by testing of the proposed research model via assessing the contributions and significance of the evident variable path coefficients. Cronbach's alpha was calculated for each of the item and the result was depicted in Table 7.

Table 7
Construct reliability for each item

Construct	Cronbach's Alpha
Perceived Usefulness (PU)	0.705
Perceived Ease of Use (PEI)	0.865
Behavioural Intention (BI)	0.848
Computer Attitude (CA)	0.794

All the measurement scales were above 0.7 which is considered good internal consistency. However, the construct item that lies just above the acceptable alpha was perceived usefulness of CT (PU), but since it is still above 0.70, the construct was still taken into consideration. Then, the next stage was to test each of the hypotheses by using Spearman rank order correlation. The result is shown in Table 8.

Table 8
Hypotheses Testing Results

Hypotheses	Path	Correlation
H_1	PU→ BI	0.067
H_2	PEI → BI	0.621**
H_3	CA → BI	0.669**

*p<0.05; ** p<0.001

The relationship between PU, PEI and CA with BI were investigated using Spearman's Rank Order correlation. Based on Table 8, there were two relationships that have strong positive correlation. Perceived ease of CT integration (PEI) significantly influenced teachers' behavioural intention (BI) [r=0.621, n=159, p<0.001], which is supporting H_2. Teachers' behavioural intention (BI) in integrating CT into their TL practices is also influenced by their computer attitude (CA) [r = 0.669, n = 159, p<0.001], supporting H_3.

Meanwhile, perceived usefulness (PU) was found not influencing teachers' behavioural intention [r=0.067].

D. What are teachers' concerns on CT integration?

In the survey form, the respondents were required to state down their related concern on the integration of CT in their daily TL practices. The respondents may select their concern from a list of options, or describe their concern in an open-ended question provided. According to the results in Table 9, 70.4% respondents stated that teachers' computer literacy is important to determine the success of CT integration. 69.8% of the respondents believed that students' basic computer literacy might be the main factor contributing to the success of CT integration in a classroom while another 69.8% respondents raised their concerns on school infrastructure, doubting if the existing school infrastructure will be fit enough to support CT integration in their TL practices. In addition, 62.8% of the respondents stated that time constraint factors will contribute to the success of integration CT in the TL. There are 81 respondents elaborated about teaching material as their concern while 72 respondents mentioned about evaluation processes as part of their concern regarding CT integration. A few of the respondents even stated their concern on time required to carry out extra TL and assessment related to CT.

Table 9
Summaries items of Teachers' Concern related to CT integration in classroom

Factors	Percent	Yes Count
Teachers' computer skills	70.4	112
Students' computer skills	69.8	111
Infrastructures issues	69.8	111
Time issues	62.8	100

V. Discussion and Conclusion

This investigation led to the conclusion that majority of the teachers have low understanding level of CT. Investigation shows that the teachers are confused on CT with the usage of computer/ICT in the classroom. Very few had correct understanding or managed to associate CT with the thought or processes involved in problem-solving. This is most probably due to the low percentage of teachers who have attended any training or workshop related to CT. This study also indicated that a large proportion of the teachers have not even attended any formal training related to computer or ICT, which is quite alarming as the future of Malaysia's competitiveness depends on the skills of workforce especially based on ICT and computer skills. This finding is crucial, indicating potential improvement in preparing teachers with CT knowledge before they can start teaching and implementing CT skills in their classroom. Without the appropriate preparation, teachers will not be able to implement the newly revised syllabus and incorporate CT into their TL [10, 57].

The second part of this research is to investigate teachers' perception regarding integration of CT skill in their TL activities. All hypotheses were supported except H_1. The study finds perceived ease of CT integration has great influence on teachers' behavioural intention in adapting CT into their TL practices. Teachers' positive attitude towards CT by having strong correlation with teachers' behavioural intention in adapting CT in their TL practices, is a significant determinant too. With these two strong correlations, the teachers most likely will integrate CT into their TL practices. Perceived usefulness of CT has the least influence on teachers' behavioural intention in CT integration in their classroom compared to the other factors. This could be since 79% of the respondents have not attended any training related to CT, making them ignorant on the benefits of CT.

Investigation shows that teachers have multiple concerns related to the attempt of integrating CT concepts into their TL. Teachers have highlighted that computer literacy either from students and teachers will be one of their concerns in CT TL delivery. Apart from that, infrastructure and time are also their main concerns in the attempt of integrating CT into their classroom. Once again, the responses acquired here showing the misunderstanding from the respondents, thinking delivery of CT will require the knowledge and usage of computer or technology. These finding is not surprising when these teachers have not attended any training related to CT. There are a few respondents who managed to state valid concerns related to CT TL, namely on teaching pedagogy such as the teaching material and assessment strategy. This is a positive indication, showing there are a few of the teachers who have the right concept on CT.

This is a pilot study on a small sample of respondents and was conducted before CT skills integration is officially and formally taught in Malaysia's classrooms, but it is able to give an overview on the teachers' understanding and their perception on CT. While it is important to introduce our students with the knowledge of CT, there is also a crucial ground work to be done to prepare the educators. Effective preparation may change the teachers' perception towards the newly improvised syllabus, receiving more positive responses from them [61]. This research calls for further works in developing teachers understanding and to increase their positive perception towards CT, for example organising workshop to facilitate teachers on how to integrate CT concept in their existing lesson plan or by developing/introducing any suitable teaching pedagogy (teaching approach, assessment method, teaching material) to assist their TL practices, especially to suit Malaysian TL environment.

References

[1] J. a. S. Cuny, Larry and Wing, Jeannette M., "Demystifying computational thinking for non-computer scientists," *unpublished.*

[2] J. M. Wing, Computational thinking. *Magazine Communications of the ACM - Self managed systems CACM,* 2006, pp. 33-35.

[3] Y. B. Kafai and Q. Burke, "Computer programming goes back to school," *Phi Delta Kappan,* vol. 95, pp. 61-65, 2013.

[4] G. Fessakis, E. Gouli, and E. Mavroudi, "Problem solving by 5-6 years old kindergarten children in a computer programming environment: A case study," *Computers & Education,* vol. 63, pp. 87-97, Apr 2013.

[5] S. Einhorn, "MicroWorlds, Computational Thinking, and 21st Century Learning," 2012.

[6] J. Richards, "Computational thinking: a discipline with uses outside the computer lab?," *Computer Weekly,* pp. 52, Jun. 2007.

[7] S. Grover and R. Pea, "Computational Thinking in K–12 A Review of the State of the Field," *Educational Researcher,* vol. 42, pp. 38-43, 2013.

[8] S. I. Ahamed, D. Brylow, R. Ge, P. Madiraju, S. J. Merrill, C. A. Struble, and J. P. Early, "Computational thinking for the sciences: a three day workshop for high school science teachers," in *Proceedings of the 41st ACM technical symposium on Computer science education*, 2010, pp. 42-46.

[9] D. Barr, J. Harrison, and L. Conery, "Computational Thinking: A Digital Age Skill for Everyone," *Learning & Leading with Technology*, vol. 38, pp. 20-23, 2011.

[10] R. Glaser, "Education and thinking: The role of knowledge," *American psychologist*, vol. 39, pp. 93, 1984.

[11] D. Viadero, "Center to Support Instruction On 'Computational Thinking'," *Education Week*, vol. 26, pp. 10, Apr. 2007.

[12] KPM, "Kurikulum Standard Sekolah Rendah KSSR," B. P. Kurikulum, Ed., 2016.

[13] C. C. o. H. Capital, J. P. K. d. KPTM, and J. P. Teknikal, "Detailed Concept Paper: Study on the Development of ICT Curriculum Standards Coordination in Primary and Secondary Schools in Malaysia," ed: Ministry of Higher Education Malaysia, 2013.

[14] K. P. Malaysia, "Pelan Pembangunan Pendidikan Malaysia 2013-2025," Kementerian Pendidikan Malaysia, 2012.

[15] A. Alibaygi, M. Karamidehkordi, and E. Karamidehkordi, "Effectiveness of rural ICT centers: A perspective from west of Iran," *Procedia Computer Science*, vol. 3, pp. 1184-1188, 2011.

[16] I. A. Bajunid, "The transformation of Malaysian society through technological advantage: ICT and education in Malaysia," *Journal of Southeast Asian Education*, vol. 2, 2012.

[17] F.-M. Chan, "ICT in Malaysian schools: Policy and strategies," in *Workshop on the Promotion of ICT Education to Narrow the Digital Divide, Tokyo*, 2002.

[18] L. Joon Sun, H. P. Ginsburg, and M. D. Preston, "Video Interactions for Teaching and Learning (VITAL): Analyzing Videos Online to Learn to Teach Early Childhood Mathematics," *Australasian Journal of Early Childhood*, vol. 34, pp. 19-23, 2009.

[19] S. Bennett, K. Maton, and L. Kervin, "The 'digital natives' debate: A critical review of the evidence," *British journal of educational technology*, vol. 39, pp. 775-786, 2008.

[20] M. Guzdial, "Education Paving the way for computational thinking," *Communications of the ACM*, vol. 51, pp. 25-27, 2008.

[21] M. Israel, J. N. Pearson, T. Tapia, Q. M. Wherfel, and G. Reese, "Supporting all learners in school-wide computational thinking: A cross-case qualitative analysis," *Computers & Education*, vol. 82, pp. 263-279, 2015.

[22] M. U. Bers, L. Flannery, E. R. Kazakoff, and A. Sullivan, "Computational thinking and tinkering: Exploration of an early childhood robotics curriculum," *Computers & Education*, vol. 72, pp. 145-157, 2014.

[23] R. Ramli, M. M. Yunus, and N. M. Ishak, "Robotic teaching for Malaysian gifted enrichment program," *Procedia - Social and Behavioral Sciences*, vol. 15, pp. 2528-2532, 2011.

[24] L. P. Flannery and M. U. Bers, "Let's Dance the Robot Hokey-Pokey!: Children's Programming Approaches and Achievement throughout Early Cognitive Development," *Journal of Research on Technology in Education (International Society for Technology in Education)*, vol. 46, pp. 81-101, 2013.

[25] A. R. Basawapatna, A. Repenning, K. H. Koh, and H. Nickerson, "The zones of proximal flow: guiding students through a space of computational thinking skills and challenges," in *Proceedings of the ninth annual international ACM conference on International computing education research*, 2013, pp. 67-74.

[26] T. S. A. R. B. Mahat, "Surat Perkeliling Ikhtisas Bil. 10/2004: Pelaksanaan Program ICT Literacy (ICTL) di Sekolah Rendah," K. P. MALAYSIA, Ed., Pusat Pentadbiran Kerajaan, 2004, pp. 2.

[27] K. P. MALAYSIA, "Modul Pengajaran TMK Tahun 3 SK," ed. Kementerian Pelajaran Malaysia, 2011.

[28] K. P. MALAYSIA, "Dokumen Standard Dunia Sains dan Teknologi Tahun 1," B. P. Kurikulum, Ed., ed. No.22, Jalan Sri Ehsan Satu, Taman Siri Ehsan, Kepong,52100 Kuala Lumpur.: Bahagian Pembangunan Kurikulum, Kementerian Pelajaran Malaysia, 2011.

[29] K. P. MALAYSIA, "Teknologi Maklumat dan Komunikasi Enam, " B. P. K. K. P. MALAYSIA, Ed., Pusat Pentadbiran Kerajaan Persekutuan, 2014.

[30] BERNAMA, "Pemikiran komputasional, sains komputer akan diajar di sekolah tahun depan," in *Utusan ONLINE*, ed. Putrajaya: Utusan ONLINE, 2016.

[31] Y. Y. Mun and Y. Hwang, "Predicting the use of web-based information systems: self-efficacy, enjoyment, learning goal orientation, and the technology acceptance model," *International journal of human-computer studies*, vol. 59, pp. 431-449, 2003.

[32] V. Barr and C. Stephenson, "Bringing computational thinking to K-12: what is Involved and what is the role of the computer science education community?," *ACM Inroads*, vol. 2, pp. 48-54, 2011.

[33] P. J. Denning, "The profession of IT: Beyond computational thinking," *Commun. ACM*, vol. 52, pp. 28-30, 2009.

[34] A. Repenning, D. Webb, and A. Ioannidou, "Scalable game design and the development of a checklist for getting computational thinking into public schools," in *Proceedings of the 41st ACM technical symposium on Computer science education*, 2010, pp. 265-269.

[35] J. J. Lu and G. H. Fletcher, "Thinking about computational thinking," in *ACM SIGCSE Bulletin*, 2009, pp. 260-264.

[36] I. Lee, F. Martin, J. Denner, B. Coulter, W. Allan, J. Erickson, J. Malyn-Smith, and L. Werner, "Computational thinking for youth in practice," *ACM Inroads*, vol. 2, pp. 32-37, 2011.

[37] A. Yadav, N. Zhou, C. Mayfield, S. Hambrusch, and J. T. Korb, "Introducing computational thinking in education courses," in *Proceedings of the 42nd ACM technical symposium on Computer science education*, 2011, pp. 465-470.

[38] A. Yadav, C. Mayfield, N. E. Zhou, S. Hambrusch, and J. T. Korb, "Computational Thinking in Elementary and Secondary Teacher Education," *Acm Transactions on Computing Education*, vol. 14, pp. 1-16, Mar 2014.

[39] J. Clark, M. Rogers, and C. Spradling, "Scratch the workshop and its implications on our world of computing," *J. Comput. Sci. Coll.*, vol. 26, pp. 235-243, 2011.

[40] M. P. Weller, E. Y.-L. Do, and M. D. Gross, "Escape machine: teaching computational thinking with a tangible state machine game," in *Proceedings of the 7th international conference on Interaction design and children*, 2008, pp. 282-289.

[41] P. Sengupta, J. S. Kinnebrew, S. Basu, G. Biswas, and D. Clark, "Integrating computational thinking with K-12 science education using agent-based computation: A theoretical framework," *Education and Information Technologies*, vol. 18, pp. 351-380, Jun 2013 2013.

[42] T. Lapidot and O. Hazzan, "Methods of teaching a computer science course for prospective teachers," *ACM SIGCSE Bulletin*, vol. 35, pp. 29-34, 2003.

[43] L. Blum and T. J. Cortina, "CS4HS: an outreach program for high school CS teachers," in *ACM SIGCSE Bulletin*, 2007, pp. 19-23.

[44] M. U. Bers, "The TangibleK Robotics Program: Applied Computational Thinking for Young Children," *Early Childhood Research & Practice*, vol. 12, no 2. 2010.

[45] D. J. Portelance, "Code and Tell: An Exploration of Peer Interviews and Computational Thinking With ScratchJr in the Early Childhood Classroom," 1589497 M.A., Tufts University, Ann Arbor, 2015.

[46] C. Kazimoglu, M. Kiernan, L. Bacon, and L. Mackinnon, "A Serious Game for Developing Computational Thinking and Learning Introductory Computer Programming," *Procedia - Social and Behavioral Sciences*, vol. 47, pp. 1991-1999, 2012.

[47] Q. Burke and Y. B. Kafai, "Programming & storytelling: opportunities for learning about coding & composition," in *Proceedings of the 9th International Conference on Interaction Design and Children*, 2010, pp. 348-351.

[48] C. Dierbach, H. Hochheiser, S. Collins, G. Jerome, C. Ariza, T. Kelleher, W. Kleinsasser, J. Dehlinger, and S. Kaza, "A model for piloting pathways for computational thinking in a general education curriculum," presented at the Proceedings of the 42nd ACM technical symposium on Computer science education, Dallas, TX, USA, 2011.

[49] V. Venkatesh, "Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model," *Information systems research*, vol. 11, pp. 342-365, 2000.

[50] O. Olumide, "Technology Acceptance Model as a predictor of using information system'to acquire information literacy skills," 2016.

[51] F. D. Davis, "User acceptance of information technology: system characteristics, user perceptions and behavioral impacts," *International journal of man-machine studies*, vol. 38, pp. 475-487, 1993.

[52] Y. Gao, "Applying the technology acceptance model (TAM) to educational hypermedia: A field study," *Journal of Educational Multimedia and Hypermedia*, vol. 14, p. 237, 2005.

[53] T. Teo, "Modelling technology acceptance in education: A study of pre-service teachers," *Computers & Education*, vol. 52, pp. 302-312, 2009.

[54] T. Teo, S. L. Wong, and C. S. Chai, "A Cross-cultural Examination of the Intention to Use Technology between Singaporean and Malaysian pre-service Teachers: An Application of the Technology Acceptance Model (TAM)," *Educational Technology & Society*, vol. 11, pp. 265-280, 2008.

[55] Y.-S. Wang, Y.-M. Wang, H.-H. Lin, and T.-I. Tang, "Determinants of user acceptance of Internet banking: an empirical study," *International journal of service industry management*, vol. 14, pp. 501-519, 2003.

[56] F. D. Davis, "Perceived Usefulness, perceived ease of use, and user accpatance of information technology," *MIS Quarterly*, vol. 13, pp. 319-340, 1989.

[57] M. Bower and K. Falkner, "Computational Thinking, the Notional Machine, Pre-service Teachers, and Research Opportunities," in *Proceedings of the 17th Australasian Computing Education Conference (ACE 2015)*, 2015, pp. 30.

[58] H. Tinmaz and I. Yakin, "Tendencies of Engineering Students on Applying Technological Innovations," *Procedia-Social and Behavioral Sciences*, vol. 176, pp. 621-626, 2015.
[59] L. Mannila, M. Peltomäki, and T. Salakoski, "What about a simple language? Analyzing the difficulties in learning to program," *Computer Science Education*, vol. 16, pp. 211-227, 2006.
[60] M. Tavakol and R. Dennick, "Making sense of Cronbach's alpha," *International journal of medical education*, vol. 2, pp. 53, 2011.
[61] D. Li, "" It's Always More Difficult Than You Plan and Imagine": Teachers' Perceived Difficulties in Introducing the Communicative Approach in South Korea," *Tesol Quarterly*, pp. 677-703, 1998.