UNIVERSITI PUTRA MALAYSIA

INFLUENCE OF PROGRAMMING ATTITUDES, COMPUTING ATTITUDES AND THINKING STYLES ON SECONDARY CHAMPION SCHOOL TEACHERS' COMPUTATIONAL THINKING SKILLS

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By

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chair : Muhd Khaizer bin Omar, PhD
Faculty : Educational Studies

Computational thinking is a skill that qualifies for the fourth industrial revolution, or better known as IR 4.0 and meets its challenges. Teachers are asked to prepare themselves with various skills as a preparatory step to face the challenges of IR 4.0 and apply 21st century skills or digital skills to students as contained in PPPM 2013 - 2025. Therefore, this study focuses on teachers in identifying the level of thinking computational, its relationship to programming and computing, and thinking style from a demographic aspect of teachers.

This study uses a descriptive and correlation study design with a sampling framework from Malaysia Digital Economy Corporation (MDEC) (2020), which represents ten Mydigitalmaker champion secondary schools in Malaysia that provide computational thinking training and continuous professional development. A total of 252 teachers were involved and selected by systematic random sampling using Microsoft excel. At the same time, the use of instruments based on previous research instruments and modifications to the items made so that they are relevant and appropriate to the current study. Modifications have been made after getting permission from the original developer of the instrument.

The results showed that programming attitude, computing attitude, and thinking style were significant in predicting computational thinking among Mydigitalmaker champion secondary school teachers in Malaysia. The impact of the study provides the finding that teachers today who have been exposed to computational thinking skills can apply these skills to their students effectively. Therefore, it is necessary to educate students in ways of cultivating programming attitudes, computing attitudes, and thinking styles that are related to the successful development of computational thinking skills. It is hoped that this study can benefit school principals and teachers, policy makers, and the ministry

of education (MoE) in setting the expected criteria for the recruitment of new teachers and the formation of 21st century students.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENGARUH SIKAP PENGATURCARAAN, SIKAP PENGKOMPUTERAN DAN GAYA BERFIKIR GURU SEKOLAH MENENGAH JUARA TERHADAP KEMAHIRAN PEMIKIRAN KOMPUTASIONAL.

Oleh

RUSNO BIN MOHD KUSNAN

November 2021

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Pemikiran komputasional adalah kemahiran yang memenuhi kelayakan untuk revolusi industri keempat, atau lebih dikenali sebagai IR 4.0 dan memenuhi cabarannya. Guru diminta untuk mempersiapkan diri dengan pelbagai kemahiran sebagai langkah persediaan untuk menghadapi cabaran IR 4.0 dan menerapkan kemahiran abad ke 21 atau kemahiran digital kepada pelajar seperti yang terkandung dalam PPPM 2013 - 2025. Oleh itu, kajian ini memberi tumpuan kepada guru dalam mengenal pasti tahap pemikiran komputasional, hubungannya dengan pengaturcaraan dan pengkomputeran, dan gaya berfikir dari aspek demografi guru.

Kajian ini menggunakan reka bentuk kajian deskriptif dan korelasi dengan rangka persampelan dari *Malaysia Digital Economy Corporation* (MDEC) (2020), yang mewakilkan sepuluh sekolah menengah juara *Mydigitalmaker* di Malaysia yang memberikan latihan pemikiran komputasional dan pengembangan profesional berterusan. Seramai 252 guru terlibat dan dipilih oleh pensampelan rawak sistematik menggunakan Microsoft Excel. Pada masa yang sama, penggunaan instrumen berdasarkan instrumen kajian sebelumnya dan pengubahsuaian terhadap item yang dilakukan sehingga relevan dan sesuai dengan kajian semasa. Pengubahsuaian telah dibuat selepas mendapat kebenaran daripada pembangun instrumen asal.

Hasil kajian menunjukkan bahawa sikap pengaturcaraan, sikap pengkomputeran, dan gaya berfikir adalah signifikan dalam meramalkan pemikiran komputasional di kalangan guru sekolah menengah juara *Mydigitalmaker* di Malaysia. Impak kajian memberikan dapatan bahawa guru pada masa kini yang telah didedahkan dengan kemahiran pemikiran komputasional dapat mengaplikasi kemahiran ini kepada pelajar mereka dengan

berkesan. Oleh itu, adalah perlu untuk mendidik pelajar dengan cara memupuk sikap pengaturcaraan, sikap pengkomputeran, dan gaya berfikir yang berkaitan dengan kejayaan pengembangan kemahiran pemikiran komputasional. Diharapkan kajian ini dapat memberi manfaat kepada pengetua dan guru sekolah, pembuat dasar, dan kementerian pendidikan (KPM) dalam menetapkan kriteria yang diharapkan untuk pengambilan guru baharu dan pembentukan pelajar abad ke-21.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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I hereby confirm that:

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This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

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LIST OF ABBREVIATIONS

ASCOPL	Attitude Scale for Computer Programming Learning
CAQ	Computing Attitude Questionnaire
CCSS	Common Core State Standards
CS	Computer Science
CT	Computational Thinking
CTS	Computational Thinking Scale
CSTA	Computer Science Teachers Association
EPRD	Education Planning and Research Division
HOTS	High Order Thinking Skills
IR	Industrial Revolution
ISTE	International Society for Technology in Education
MDEC	Malaysia Digital Economy Corporation
MoE	Ministry of Education
NGSS	Next Generation Science Standards
STEM	Science, Technology, Engineering, Mathematic
TSIT	Thinking Styles Inventory for Teachers
WEF	World Economic Forum

CHAPTER 1

INTRODUCTION

1.1 Background

Rapid technology advancements in a country will get the ability to boost the economy and leads the country to the Fourth Industrial Revolution (IR 4.0). The advancement of new technologies in IR 4.0 eliminates the gaps between the physical, digital and biological worlds. Therefore, early awareness of developments in the educational curriculum and technological advancement is the first step in driving the nation's economy. In line with the country's efforts to meet the challenges of IR 4.0, the importance of education, including Science, Technology, Engineering and Mathematics (STEM) among students, has been strengthened (*Bahagian Pembangunan Kurikulum* [BPK], 2018). Former Malaysian minister of education, Dr Maszlee Malik in his speech at the colloquium of revolutionary industry 4.0, education has highlighted that the key components in the implementation of IR 4.0 in school are the areas of Design and Technology (RBT), the Basics of Computer Science (ASK) and other elective STEM subjects such as Physics, Biology, Chemistry, Engineering and Digital Entrepreneurship *(Kementerian Pendidikan Malaysia* [KPM], 2019). The emphasis will be on exposing students to potential capabilities preparation for IR 4.0 education foundations and digital technologies.

Computational thinking (CT) was recognized as a fundamental analytical thinking skill, the required component to navigate the digital world for students (Common Core State Standards [CCSS], 2010; Next Generation Science Standards [NGSS], 2013; Wing, 2006) and also as a core competence skill in the U.S. economy (Yang, 2019). In conclusion, CT is crucial to scientific and technological advances and a valuable skill for modern citizens in general (Fessakis et al., 2018) role as a language in STEM fields (Sengupta et al., 2018).

CT is a digital skill monitored through implementing school improvement policy as enshrined in the Malaysia National Education Policy 2017 (KPM, 2017). CT's importance in the education system has led the Ministry of Education Malaysia (MoE) to increase the students' awareness of CT more clearly. Thus, the integration of CT into *Kurikulum Standard Sekolah Rendah* (KSSR), *Kurikulum Standard Sekolah Menengah* (KSSM) in 2017 and STEM in 2018 has provided the impression that these skills are needed to be applied to students at an early stage (BPK, 2018). Moreover, Dr Maszlee Malik has embarked on CT skills' critical role as one of the thinking element traits employed for IR 4.0 in his speech (KPM, 2019).

1.1.1 Fourth Industrial Revolution (IR 4.0)

The core concept of IR 4.0 focuses on interactive academics and practitioners in the development cycle in response to success criteria, is built based on German initiatives (Bundesministerium für Wirtschaft und Energie, 2017). This IR 4.0 philosophy has been expanded nationally under various names such as *Industrie du future* (France), *Fabrica Intelligente* (Italy), *Industrial Internet* (United States) and *Industry4WRD: National Policy on Industry* (Malaysia).

In line with the National Policy on Industry 4.0 plan, Malaysia is believed to be able to strengthen the manufacturing sector and pave the way for productivity improvement, job creation, innovation capabilities, high talent pools and ultimately economic and social well-being (MITI, 2018). Schwab (2016) in his speech at World Economic Forum (WEF) Geneva, IR 4.0 was the stage where talent will represent critical production factors in the future and create a "high-skill with high-pay" job market and "low-skill with low-pay". As claimed by the "Future of Jobs" report 2018 at the World Economic Forum, the top skills that crucially needed by employers starting from 2020 are complex problem-solving, critical thinking, creativity, people management, coordinating with others, emotional intelligence, judgement and decision making, service orientation, negotiation, and cognitive flexibility (WEF, 2018).

Deloitte Global's 2020 Readiness Report, the fourth industrial revolution at the intersection of readiness and responsibility, preparing workers to meet the demands of Industry 4.0, continues to be a major business challenge, and leaders are sceptical of how their organization is faring. Only ten percent of executives surveyed said they had made significant progress in understanding what skills needed in the future, and only one-fifth agreed that their organization was ready. The result indicates that skills are essential in the future in line with the needs and changes that IR 4.0 brings to human life, work, and technology (Deloitte Insights, 2020).

Compared to the past industrial revolutions, IR 4.0 will create new jobs and eliminate some of the existing jobs. The impact of IR 4.0 will also lead to changes in the education industry. Education approaches have now gradually become more technology-driven education. To keep the momentum, both teachers and students are strongly focused on developing expertise in modern technologies at all levels to improve the use of teaching and active learning technology. Drucker (1997) states that there will be significant changes in how teaching and learning will be conducted in the future.

Thus, new education systems must be created to meet evolving needs of IR 4.0. Haseeb (2018) suggested that new educational programs must be developed so that changes in demand can meet the competitive advantage over the long term, as the precise forecasting of what lies ahead is constantly a challenge. Challenges to face in implementing IR 4.0 are students need to be equipped with

ICT, collaborative skills, interested in lifelong learning, critical and creative thinking skills and communicative skills as embodied in the Malaysian Education Development Plan (PPPM) for Higher Education 2015-2025, Education 4.0 framework.

1.1.2 Education 4.0

Education 4.0 is a phenomenon which responses to the needs of IR 4.0 where human and technology are harmoniously aligned to enable various new possibilities to adopt simulation and virtual reality, artificial intelligence, Internet of Thing (IoT), cybersecurity, cloud computing, additional material manufacture, chain provider, data analysis, and an automation robot (Schwab, 2015; Marie Paz, 2018). Education 4.0 inspired students to acquire the necessary skills and expertise and develop digital capabilities at all levels (Fisk, 2017). In general, it is a believed institute that encourages intelligent and smart thinking in education.

Education 4.0 is also known as an advanced educational framework for developing skills and expertise in the new manufacturing age to create a competitive environment to prepare future employees who adhere to Industry 4.0 standards (Mourtzis et al., 2019), the use of technology in teaching, learning and offering insights into and utilizing information and technology in the processes of learning innovation (Dunwill, 2016). World Economic Forum (WEF) (2020) for schools in the future explained the initiative of Education 4.0 aims to emphasis on the transformation of primary and secondary level of education systems to produce more talented and all-rounded generation. This will provide wider opportunities for students as well as enable students to achieve an effective outcomes and future-proof talent based on their specific interests in science or the profession.

Teachers could teach the whole students instead of the classroom by using methods and strategies to support personalized learning purpose. This contributes to the improvement of students' learning outcomes and better school performance based on the measures teachers or educators deliver (Sharma, 2019). Education 4.0 aims to improve performance by enhancing teacher skills, improving students' learning outcomes and facilitate work using the best approaches and technologies.

1.1.3 Educational Technology for the 21st Century

The term "educational technology" is widely used in the education profession which focuses on 21st century learning and teaching. Education technology plays a major role in improving students' outcomes to a higher level than before by using of tools, technologies, processes, procedures, resources, and strategies to improve learning experiences in different fields, including informal learning, formal learning, non-formal learning, lifelong learning, on-demand learning, in-place training and just-in-time learning (Huang et al., 2019).

Educators today tend to view teaching or educating of technology, particularly into more modern digital devices such as computers, mobile phones and tablets as tools or equipment of teaching and learning process. However, education technology is not new and not restricted to the use of devices; it's only modern tools and techniques that are emerging in the long-standing field of education itself. Education technology is intended to help educators and students simultaneously to transfer and enhance knowledge. Various studies have shown that the value of education technology is directly linked to the ability of educators, the more skilled educators use technology the more students can understand it (Guasch et al., 2010; Hennessy et al., 2010, Hechter & Vermette, 2013; Herrero et al., 2015). Hence, technology is an important and efficient guide to enhance what students know and can do.

Since education includes everything that aims to enhance learning, including those involved in learning development and promotion, its performance also covers the educational technology discipline (Merrill, 2007, 2017). Education technologies will prove that education can be effectively and efficiently distributed. According to Hartley et al. (2010) among the dimensions relevant to learning technologies are as follows: architecture and engineering of computers and software, design of research human-computer interaction, the psychology of learning, program evaluation, project management, social interaction, and system thinking.

1.1.4 Computational Thinking Skills for the Future

Computational Thinking (CT) is an important competence which is required to adapt the future. CT is a universal skill and no longer just a stereotype in skills required by computer scientist. CT was firstly introduced by Seymour Papert (1980) in his book "Mindstorms: Children, Computers, and Powerful Ideas" and then Jeanette Wing popularized the CT concept widely. Jeanette Wing (2008) justified the CT consists of theoretical, engineering and scientific perspectives, and everyone can think like a computer scientist and apply CT concepts in any situation to easily solve a problem, afterward gave the following definition of CT:

> "Computational Thinking is the consideration processes concerned in devising problems and their solutions so that the solutions are represented in form that can be effectively carried out by an information-processing-agent" (Cuny et al., 2010, p. 1).

Based on *Dokumen Standard Kurikulum Pentaksiran* (DSKP), CT is a skill of using the concepts of logical reasoning, algorithms, solving, pattern recognition, scaling and assessment in computer-assisted problem-solving (KPM, 2017).

Regarding Malaysia Digital Economy Corporation (MDEC) 2016, the objectives of integrating CT into education are to:

i. Help teachers to guide or assist their students better in finding new ways in solving problems which seem impossible to solve.
ii. Help teachers to improve teaching and facilitate practices or activities.
iii. Enrich teaching process and students' exploration of a subject without the use or access to technology.
iv. Enhance students' confidence primarily in dealing with unclear, complex or open close issues.

CT's integration is more focusing as 21st century skills for all students have recently led to several curriculum initiatives to integrate them into KSSM classes. Students learn the basic principles and concepts of digital technology building to become an individual with CT and understand that today's digital technology can solve future problems. In accordance with the Malaysian Education Blueprint (PPPM) 2013 - 2025, in the 21st century, students will not only act as knowledgeable technology users but also inventors and new idea triggers with a background in STEM education (PADU, 2013).

The integration of CT into STEM education is intended to encourage students to apply CT with Mathematical Thinking (MT) to their ability as a team or as individuals to formulate complex problems with simple logic solutions that can be implemented by humans or computers effectively. Students can then apply CT to STEM through an inquiry approach, problem-solving method, or projects in the context of everyday life, the environment, and the local community globally.

1.2 Problem Statement

Malaysian teachers were found to be uncreative in terms of skills or teaching delivery to students to be creative (Chua, 2011; Kamarulzaman, 2017). Teachers' thinking styles do not help teachers think creatively, instead they need to be known in advance to get the best results whether having critical and creative thinking (Hashmi et al., 2018). This is as the study of Danuri et al. (2016) who found that teachers are the main dominant factor influencing students' weaknesses in programming in Malaysia. The statement gives a negative stigma that programming is something that is difficult to learn and master (Ahmad & Ghazali, 2020; Estapa et al., 2017) and even boring (Cheah, 2019). Thus, the personal traits and attitudes of teachers or students become negative, in turn contributing to programming learning failure (Robins, 2019), and hindering the integration of computational thinking (CT) or technology innovation in education (Fessakis & Prantsoudi, 2019; Kanafadzi & Jamaludin, 2021). Thus, it affects the level of understanding and computational thinking of teachers who are at a low level (Ling et al., 2017).

In addition, limited research on CT skills in Malaysia among teachers requires further research and it is considered a research gap that will be filled by current researchers. The reality of CT research in Malaysia is still considered less and requires more CT-related studies to be conducted (Ling et al., 2019; Saad, 2020). Most CT research is from developing countries other than Malaysia, which apply CT skills in their education curriculum (Heintz et al., 2016) and focus only on students (Ling et al., 2018) but limited to teachers (Sidek et al., 2020). Thus, Ling et al. (2017) conducted a pilot research and found that teachers do not know the benefits of CT and teachers' CT skill are at a low level. They expressed concern over this situation as the future of Malaysia's competitiveness depended on the skills of the workforce especially ICT and computer skills. Furthermore, if teachers have not been provided with solid skills and knowledge related to the teaching of thinking skills, then the Ministry of Education Malaysia desire to produce a generation with thinking skills will fail (Jaganathan & Subramaniam, 2016).

Therefore, the researcher thinks it is necessary to conduct a CT-related study to identify the level of computational thinking skills, thinking styles and attitudes of Mydigitalmaker champion teachers in secondary schools throughout Malaysia. In addition, to investigate whether there is an influence between independent variables namely programming attitude, computing attitude, and thinking style on the dependent variable, CT skills. The findings of the study can be used to see the extent to which teachers' programming and computing attitudes towards computational thinking skills have been implemented since 2017.

1.3 Research Objective

This research is conducted to investigate the relationship between demographic, programming attitudes, computing attitudes, thinking styles, and computational thinking among secondary school teachers. The specific objectives of this research are:

i. To assess the level of computational thinking among secondary school teachers in Malaysia.
ii. To determine whether the computational thinking among secondary school teachers differ significantly based on the selected demographic characteristics such as age, and teaching experience.
iii. To determine whether the three variables namely, programming attitudes, computing attitudes, and thinking styles of secondary school teachers have significant impact on their computational thinking.

1.4 Research Questions

In accordance with the purpose of this research, the following research questions are:

i. What is the level of computational thinking among secondary school teachers in Malaysia?
ii. Is there any significant difference computational thinking between selected demographic backgrounds of secondary school teachers (i.e. age, teaching experience)?
iii. Do programming attitudes, computing attitudes and thinking styles provide significant influence on the level of computational thinking among the secondary school teachers in Malaysia?

1.5 Research Hypothesis

H_{01} Computational Thinking among secondary school teachers no differ significantly based on their age.

H_{02} Computational Thinking among secondary school teachers no differ significantly based on their teaching experience.

H_{03} Programming Attitudes has no significant influence on Computational Thinking among secondary school teachers.

H_{04} Computing Attitudes has no significant influence on Computational Thinking among secondary school teachers.

H_{05} Thinking Styles has no significant influence on Computational Thinking among secondary school teachers.

1.6 Research Significance

Teachers are the backbone of a country's education. Anything that benefits students because of education policy requires teachers as implementers (Day, 2014; Robinson, 2012). In fact, teachers are a major booster in the effort to change (Porter et al., 2015).

Therefore, the findings of this research may contribute to the body of knowledge and the importance to improve teachers' computational thinking and programming skills to ensure that teachers effectively integrate computational thinking in their classrooms. Computational thinking involves a set of skills that describe many of the same abilities are integrate to programming and problem-solving with computers. Teachers could develop understanding and awareness about improving their characteristics and teaching practices in order to foster computational thinking among students. Determining the characteristics of computational thinking may assist researchers and teachers to discover what kind of techniques may help an individual to solve problems like a computer.

It is hoped that the findings of the research will contribute to an understanding for the teachers about teachers' computational thinking teaching practices. Thus, it will help to identify the relationship between teachers' computational thinking characteristics, programming, computing and thinking styles. Additionally, this research may be beneficial to (1) Malaysian school principals and teachers which to use this research in finding the improvement of school dimension and teachers' teaching instruction, (2) help the schools and MoE towards better policy choices with more clarity and implementation of curriculum policies. (3) those who prepare and provide Malaysian secondary school teachers with in-service professional development, (4) establish new teachers' recruitment expectations.

Limited studies have been carried out to determine computational thinking usage among teachers in the Malaysian school environment in their teaching. Although there were only ten Malaysian schools involved in this analysis, data are generally available in similar demographic areas. This research hopes to increase consciousness of encouraging and incorporating computational thinking into the cycle of teaching literacy. Thus, with the advent of this research, hopefully it will help stakeholders such as the Ministry of Education, Teacher Training Institutions and school's administrators as an alternative to teaching practices and considering existing learning to prepare students for twenty-first-century careers which makes it essential for teachers to be prepared to integrate computational thinking concepts and to become computationally literate. Finally, the research findings that can serve as a base for more research on the efficacy of computational thinking learning by the research community.

1.7 Scope and Limitation

The research covers to the factor effect of secondary school teachers on the computational thinking level. There are four main parts in this research which focus on demographic, attitude towards programming, attitude towards computing, and ways of thinking style. The focus of this research is to identify the relationship of computational thinking scale among secondary school teachers on attitude towards programming, computing, and teachers' thinking styles. Achieving focus of the research, schools' selection was based on the sampling framework provided by *Mydigitalmaker* MDEC (2020). Therefore, this research is restricted to the *Mydigitalmaker* champion secondary school teachers in Malaysia only and not for all secondary school teachers generally.

This study uses a quantitative method based on Gagne's cognitive theory (1985) and mental self-government theory (1988) by using questionnaires produced by several past researchers such as (Korkmaz et al., 2017); Korkmaz and Altun

(2014); Sternberg and Grigorenko (1993); Yadav et al. (2014); to identify the relationship between computational thinking skills among Mydigitalmaker champion secondary school teachers in Malaysia. The research is valid to represent the target population. However, the results of the research can only be used in general in different locations and populations if the characteristics of the respondents, sampling framework, and the sampling method are the same as the sample studied.

Details on the selected elements for each theory will be discussed in the highlighted section of the research (Chapter 2). In addition, the research is also limited to the evaluation of variables in the research based on the instrument to determine the relationship between teachers' computational thinking, thinking styles, programming attitudes, and computing attitudes. The CTS instrument in the research will only focus on the variables computational thinking. The ASCOPL instrument was used to determine the programming attitudes of a teacher's computational thinking. The CAQ instrument focuses on the computing attitudes towards computational thinking of teachers. Meanwhile, the TSIT instrument is used to determine teachers' thinking styles on teachers' computational thinking.

The analysis of this study consists of two analyses namely descriptive analysis and inferential analysis. Inferential analysis includes correlation analysis and multiple linear regression analysis where data are analysed using SPSS software version 25.0 only and does not involve the use of SEM-AMOS software method which can also be used to test the variables of this study. Therefore, this study was limited to revolving around the specified variables only.

1.8 Definition of Terms

Terms and phrases used in this research have been defined in the context of this research to ensure the accuracy of the interpretation. The definition is intended to explain in more detail to enable readers to understand the term in this research and not to be confused with the general terms.

1.8.1 Computational Thinking

Computational Thinking (CT) emphasizes a combination of five elements namely creativity, algorithm thinking, cooperativity, critical thinking, and problem-solving (ISTE, 2015). Regarding to ISTE (2015), CT refers to computer-like thinking and uses computer science (CS) concepts to solve problems. Denning and Tedre (2019) define CT as a concept and model of a discipline that harnesses the power of computing and is central to computer science. Hence, computational thinking is a dependent variable in the research to determine the level of computational thinking of Malaysian teachers referred to the five elements which are creativity, algorithm thinking, cooperativity, critical thinking, and problem-solving.

1.8.1.1 Creativity

According to Korkmaz et al. (2017), creativity is developing genuine ideas that are different from the usual and finding solutions with programming methods. In the context of this study, creativity encompasses the structure of thinking in teachers in solving critical problems.

1.8.1.2 Algorithm thinking

Korkmaz et al. (2017) stated that algorithmic thinking is an ability to think in detail and purposefully in the issue of problem solving methods by placing the proceedings in sequence. Researchers use the same definition which is the solution done by the teacher in an orderly or systematic manner.

1.8.1.3 Cooperativity

Cooperativity was expressed by Korkmaz et al. (2017) as an efficient learning method at all levels because of its contribution to academic success, information sharing and creating social relationships in solving complex problems. Researchers use the same definition as previous researchers (Korkmaz et al., 2017) as a teacher’s approach to solving complex problems.

1.8.1.4 Critical thinking

Korkmaz et al. (2017) stated that critical thinking is one of the high -level thinking skills with overall attitude, and the information used in the justification of evaluation in terms of consistency and validity. In other words, problems can be solved with critical thinking. Researchers use the same conclusion that problem solving uses critical thinking.

1.8.1.5 Problem-solving

According to Korkmaz et al. (2017), problem solving is a solution faced in life and becomes a priority in the field of education. It is a process at the problem -solving stage that needs to be collected and used systematically. In this study, when programming is considered as a problem -solving process, then these skills cannot be neglected in CT thinking skills.

1.8.2 Programming Attitudes

Attitudes involve psychological tendencies that indicate an assessment of a person, object, situation, event or idea being faced with either accepting or rejecting the matter (Eagly & Chaiken, 1993). According to Morse et al. (2011) attitudes can be defined as behaviors, feelings, individual experiences as well as activities towards an objective or situation. Programming attitudes in this study refer to the extent to which teachers demonstrate a good attitude to use programming in the formation of computational thinking skills. Programming attitude is measured based on 3 components namely willingness, negativity, and necessity.

1.8.2.1 Willingness

In the attitude factor, Korkmaz and Altun (2014) label willingness as individual intention that leads to variation in willingness to act on computer programming learning. In this study, Willingness refers to a teacher's willingness to learn programming by contributing to reactions to CT skills.

1.8.2.2 Negativity

This dimension is also referred to as a description of negative attitudes. In the study of Korkmaz and Altun (2014), negativity revealed negative opinions related to programming learning. While in this study, negativity looks at the negative opinions of teachers related to programming learning to build CT skills.

1.8.2.3 Necessity

Korkmaz and Altun (2014) state that the necessity dimension encompasses matters related to whether individuals think that whether they need to learn programming or not. Therefore, in the context of this study, necessity refers to whether there is a need for programming learning in building CT skills among teachers.

1.8.3 Computing Attitudes

In general, attitude means the behavior of teachers as a result of an experience or teaching and learning activities performed (Morse et al., 2011). In this study, attitude refers to a teacher's positive or negative response to computing in shaping computational thinking skills. Computing attitudes are measured based on 5 components, namely definition, comfort, interest, classroom, and career/future use. Attitude towards computing refer to teachers' feeling and interest about introducing computational thinking into their classroom, understanding of computational thinking, comfort levels on computers and computing, and influence to careers.

1.8.3.1 Definition

According to Yadav et al. (2014) given that there are a handful of teachers who do not have a history or background in computer science, then this concept is illustrated with concrete examples from everyday life and associates the term computational thinking with teachers 'personal experiences. In the context of this study, the researcher associated a clear term linking computing with computational thinking, so that teachers are not confused with the various definitions.

1.8.3.2 Comfort

Comfort according to the study of Yadav et al. (2014) are oriented to the level of comfort of teachers towards computing and computational thinking. Teachers build comfort and understanding that computing plays a role in their careers. However, in this study the comfort level was oriented to the respondents i.e. teachers, whether they were comfortable with computing and CT, or vice versa.

1.8.3.3 Interest

Interest in the study of Yadav et al. (2014) refer to how teachers respond with their own understanding of computing concepts and interest in computer science and computational thinking. Therefore, this study retains the term to which the study of Yadav et al. (2014).

1.8.3.4 Classroom

Classroom dimensions in the study of Yadav et al. (2014) highlighted teachers' thinking on how to integrate CT into the classroom i.e. "computer -based learning by problem solving." In addition, CT in the classroom also involves teachers teaching students to solve problems. In this study, the researcher only set to teacher thinking and how to integrate CT into the classroom.

1.8.3.5 Career/Future Use

The Career/Future Use dimension is oriented to the study of Yadav et al. (2014) on teachers' views on how CT can influence future careers and may play an important role in increasing the number of students pursuing computer science. Therefore, this study is only guided by the views of teachers as expressed by Yadav et al. (2014).

1.8.4 Thinking Styles

Thinking styles are regarded by various biological, psychological and social factors as a dynamic structure. Thinking styles are a preferred way of expressing or using one or more abilities (Grigorenko & Sternberg, 1995) and related performance of skill, knowledge, abilities to in which individuals prefer to use while finding a solution (Sternberg & Grigorenko, 1997). In this research outlines the role of thinking style among teachers, which includes three styles namely legislative, executive, and judicial along with the effect of thinking style on computational thinking. Teachers coordinate their thoughts and actions according to internal and external desires as individuals.

1.8.4.1 Legislative

Legislative according to Sternberg (1993), will generally seek and enjoy a lot of independence, teachers are likely to feel frustrated if told what to do, or if given a lot of unwanted and unnecessary guidance. The reviewer uses the context of the definition of Legislative style stated by Sternberg.

1.8.4.2 Executive

Executive is defined by Sternberg (1993) as a style that prefers to be advised, and guided. Individuals with an executive style will thrive under a teaching system that involves guidance and tends to be a consumer of knowledge. The researcher used the same definition context by Sternberg (1993) in this study.

1.8.4.3 Judicial

Judicial is defined by Sternberg (1993) as a style that prefers to evaluate rules and procedures, and who prefer problems where one can analyse and evaluate existing things and ideas, e.g. teachers give evaluations as part of class response selection. In this study, the researcher used the same definition stated by Sternberg.

1.9 Chapter Summary

In conclusion, this research aims to identify the level of thinking styles and think on computational thinking among secondary school teachers in the digital maker champion school. Educators must own computational thinking skills to serve as good role models and positively influence their students to adopt digital thinking, which competencies to be a success in the digital era. Educators need to provide students with opportunities to apply thinking skills to solve problems using technology in their daily lives.

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