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Computational Thinking and its Relationship with Mathematics Teachers' Perception of Implementation in Problem-Solving Skills

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Abstract

Computational Thinking (CT) is a skill that encompasses various strategies and is used as a problem-solving skill. Nonetheless, there remains a lack in the literature on the understanding of CT knowledge among mathematics teachers in regard to problem-solving skills development. Therefore, the main aim of this study is to investigate such relation based on primary school mathematics teachers' perception as to their knowledge. The research is quantitative using a questionnaire. For this research, a simple random sampling was employed to select 121 primary school mathematics teachers in Klang district of Selangor as the study sample. The results revealed a relationship, level in CT and students' perceptions about the implementation of it within problem-solving skills. Results may thus reflect higher CT knowledge making it more likely to perceive that they implement greater levels of CT in their problem-solving. Finally, it is recommended that professional development programs for mathematics teachers be designed to improve the belief of its implementation in teaching and learning.

Keywords: Perception, Computational Thinking, Problem-Solving Skills, Primary School Mathematics Teachers.

Introduction

Problem-solving is important in the context of mathematics education for all people around our world. Good command of these skills is important because they help students in solving real-life problems pertaining to mathematics. According to Ismail et al (2021), mathematical problem-solving skills and higher-order thinking are intermingled since students creatively approach problems within critical reflection. These skills, when developed, can go a long way in implementing mathematics teaching-learning effectively and hitting the nail on the head in terms of learning outcome.

To solve mathematical problems efficiently, many problem-solving models are being conditionally used, such as the Mayer model (1983), Polya's model (1973), and Schoenfeld`s model (1985). The Polya model is introduced in the curriculum via the Secondary School Integrated Curriculum (KBSM) and Primary School (Revised KBSR 2017). Since this model consists of four steps, it is also more accessible and was likewise often used in mathematical problem-solving research conducted among Malaysians (Lau & Limok 2003; Noor Azlan & Lui, 2002). Polya's model (1973) suggests there are four stages involved in solving mathematical problems; understanding the problem, planning for a solution, implementing that plan and reviewing. This model can be used as a reference for students to solve mathematical problems and must be taught by teachers for students to truly understand problem-solving.

Moreover, mathematics education takes centre stage in the Malaysian Education Development Plan (PPPM) 2013-2025 (KPM, 2012). It is part of a prong to provide for effective mastery of problem-solving by teachers. The document also states that professional development programs will continue to strengthen the skills and abilities of mathematics teachers (KPM, 2012). The move is aimed at filling the void in content knowledge and pedagogical methods to deliver under the new curriculum during exam times whereby teachers will pay more focus on attempting, reviewing, and applying for better ways of creating problem-solving skills. Thus, teachers must seriously consider various related knowledge areas such as computational thinking (CT) so that their students gain problem-solving capabilities.

Computational thinking has been increasingly shaped by the fourth industrial revolution and 21st-century education, regarding all subjects but particularly for mathematical problems. CT is made up of several strategies used to comprehend and solve problems throughout disciplines — with an emphasis on STEM for studying concepts as well as practicing problem-solving (Wing, 2008). These include algorithmic thinking, logical reasoning, conceptualization (abstraction), problem decomposition and pattern recognition/specialization with data generalization strategies (Corradini et al., 2017). Algorithmic thinking refers to a systematic, step-based approach or well-structured blueprint of directions used in the design and development process for problem-solving tasks and goal-seeking activities (Wing, 2010). Algorithms are the resulting outputs of this CT process (Aho, 2012). This CT element helps people concentrate on methodological solutions. Wing (2010) defines reasoning as the use of logical thinking to understand, produce and verify facts. The implementation of CT can facilitate problem-solving skills in maths indirectly.

In the light of current prognosis trends, CT must be considered a craft adapted according to ongoing educational progress. In teaching and learning, this can be incorporated by all teachers to improve their problem-solving skills, in particular mathematics teachers. Nevertheless, the teachers' opinions are the most important for a sustainable implementation. Thus, it is significant for the CT community to consider how mathematics teachers perceive what involving CT actually means. For example, teachers who have positive initial perceptions of CT´s applicability may be more confident and, therefore, apply it more effectively (Avcı & Deniz, 2022; Erdogan, 2020).

Previous research on CT has been conducted by other researchers, primarily focusing on students, as seen in studies by Barr and Chris (2011), Yadav et al. (2011), and Grover and Pea (2013). Research by Belanger et al. (2018) also examined CT among students aged 10-16, focusing on problem-solving. Furthermore, prior studies have mainly concentrated on the classroom context, such as the implementation and application of CT within classroom settings (Rogers, 2020) and CT in mathematics education (Wan et al., 2023). Studies on CT readiness have also been conducted on pre-service teachers (Napiah & Hashim, 2021). However, research on mathematics teachers, particularly primary school mathematics teachers, remains limited. Therefore, research on CT levels and perceptions of CT implementation should be conducted. The study will explore the relationship between CT knowledge and perceptions of its implementation in problem-solving skills. This research focuses on primary school teachers who teach fundamental concepts to students before they advance to higher education.

The research questions for this study are as follows:
i. What is the level of computational thinking knowledge in problem-solving skills among primary school mathematics teachers?
ii. What is the level of perception of computational thinking implementation in problem-solving skills among primary school mathematics teachers?
iii. To what extent is the relationship between the level of computational thinking knowledge and its implementation perception in problem-solving skills among primary school mathematics teachers?
Hypothesis:
H_0: There is no significant relationship between the level of computational thinking knowledge and its implementation perception in problem-solving skills among primary school mathematics teachers.

Literature Review

Computational Thinking

Computational thinking can be described as the way people think logically and systematically in problem-solving. In CT, the principles of computer science and skills of steps are applied, and instructions are provided to the computer to perform tasks. This process allows individuals to solve complex and difficult problems more effectively by thinking like a computer scientist rather than a computer itself (Wing, 2006). Computers are machines that lack independent thinking; hence instructions are given to computers, and they follow simple and complex formulae. As a result, formulation of most problems is such that the solutions are in the form of steps or algorithms that can be executed by computers. However, the concepts of CT might not necessarily involve computers in solving the problems. Subramaniam et al. (2022) point out that CT activities are not machines or gadget use only. The methods applied in the problem solutions must be illustrated in a way systematically understandable to the machines while acceptable by human beings in a logical manner.

In Malaysia, the Teacher Education Division (BPG) has also introduced the concept of CT. According to BPG (2016), CT is a skill used to understand how something or a problem can occur systematically and logically. The Curriculum Development Division (2016a) states that there are six elements or CT skills used as reference models in school curricula. These elements include logic, algorithms, decomposition, pattern recognition, abstraction, and evaluation. CT can help address complex problems, understand real issues, and develop problem-solving methods. These methods help solve problems in a systematic and sequential manner. To ensure effective problem-solving, elements of CT can be utilized to enhance problem-solving skills.

Problem-Solving Models

CT is an essential skill for solving problems in a safe way and includes many important steps. One of the most famous problem-solving methods is Polya (Maharani et al., 2019). In his still popular book, How To Solve It (1945), George Polya proposed four principles in solving mathematical problems: understanding the problem, devising a plan, executing that plan and checking/evaluating to be sure your solution is valid.

The first step in solving the problem is training. First, the teacher explains to the students exactly what is required from them. In order to be sure that the students understand the problem, they have to be asked to translate it into their own words and say what the question is about. There is a variety of methods to understand the problem. Cathcart et al. (2003) state that their work is dedicated to helping students learn to talk about the problem in their own words and understand it more deeply. The second step is applying a decision-making strategy. According to Polya (1945), there are several strategies for solving problems. The most effective of them are the following: trial and error, making a drawing, drawing up a plan of the task, searching for logical structure, and simplifying the task. A person can choose the strategy that is suitable for him or her depending on the skills of solving problems that were acquired earlier.

The next step is strategy implementation. To this end, students should translate and process the information before calculating using formulae or other methods. Several approaches can be utilized during the strategy implementation stage (Lichtenberg, 2003). Finally, learners should review the solved problem. Nevertheless, many stop working once they complete the third process, leading to poor results (Van et al., 2010). Therefore, teachers should guide students to master the necessary programming skill to succeed in mathematics subjects. In this regard, teachers can combine Polya's method technique with CT to help students perceive CT implementation in problem-solving. They may introduce a process that includes understanding the problem, planning, executing the plan, and finally reviewing the solution.

Perceptions Among Primary School Mathematics Teachers

Each teacher, especially primary school mathematics teachers, has their own perceptions and subjective response. These perceptions are influenced by the teacher's perception of various factors affecting the teacher and such perceptions are based on their assumption that students who achieve more report more mathematical confidence in comparisons with their peers. Habyley et al (2021), claim that high-achieving students have mathematical self-confidence while Dan (2021) states that experienced teachers' perceptions of students and the school environment are likely to be positive. These teachers also have a lot of skills and knowledge that are related to their experiences. However, the perceptions of pre-service teachers having inadequate confidence of becoming an effective mathematical teacher are supported by Thai and Hine (2019), who concluded that these teachers are not ready to teach mathematics despite having done the courses and internship.

Moreover, teachers' perceptions are intimately linked to student performance and the classroom learning atmosphere (Thai & Hine, 2019). Thus, during teacher preparation, teachers' perceptions are an essential consideration to make certain that they are adequately equipped to become efficient mathematics teachers. Additionally, professional growth has an effect on teachers' perceptions. Teachers' sense of voracity can be instilled with abilities such as thinking abilities and pedagogical skills. For example, according to some studies, those who had a good first impression of CT had a certain level of confidence and could teach efficiently (Avcı & Deniz, 2022; Erdogan, 2020). It is important to note that this work focuses on how knowing the CT concept positively affects the perception of CT methods as applied to teaching mathematics problem-solving abilities.

Research Methodology

Research Design

A survey research design is used in this study following a quantitative research approach. According to Ghazali and Sufean (2021), a quantitative study pertains to a type of scholarly investigation aimed at looking into the existing relationships among variables and the initially proposed hypotheses. A survey design is chosen in light of the purpose of the research to measure levels of CT knowledge and its connection to the perception of its application in problem-solving skills.

Respondents

The study is targeted at the primary school mathematics teachers in daily school within the district of Klang, Selangor. Klang district was selected due to a) its suitability for the study's objectives, b) geographical proximity to the researcher, and c) good cooperation from the schools. The study sample was chosen by the researcher at 120 based on the scientific calculation using the website http://www.raosoft.com/. This choice ensures that the sample characteristics can be generalized to the population (Sekaran, 2006). The sample technique used was simple random sampling. The procedure is explained as follows based on Merrigan and Huston (2004): a. The researcher first identifies the study sample to be selected. b. The researcher will then prepare a complete list of the population for random sampling. c. Finally, the researcher will select the sample based on the probability of each qualified member in the list to be chosen to be in the study.

Data Collection and Analysis Procedures

The instrument of data collection is questionnaires for this study. Furthermore, because the data are confidential (compared to face-to-face methods), people are more likely to answer honestly if they agree that participation will help them in some way (Ghazali & Sufean, 2021). The study used Google Forms for an online survey. This online data collection can be automated, which saves time as well as effort for the researcher (Wright, 2005).

The questionnaire was modified from Mat Rahim (2021), and Napiah (2021). This led the researcher and supervisor to brainstorm ideas about how they might adjust previously used study forms so that they could fit within the constraints of this objectives and questions. The survey contains three parts. Section A describes the profile of respondents and elements related to CT can be found in Sections B and C. The CT-related sections use a Likert scale with five options: (5) strongly agree, (4) agree, (3) disagree, (2) strongly disagree, and (1) strongly disagree. According to Chyung (2007), any scale without a "Not Sure" option can distort the results and validity of the study. The total number of items is 24, as detailed in Table 1.

Table 1
Questionnaire Instrument

Section	Item Numbers	Item Numbers
A. Respondent Background	A1-A3	3
B. Aspects of Computational Thinking Knowledge	B1-B10	10
C. Aspects of Perception of Computational Thinking Implementation in Problem-Solving Skills	D1-D6	6
Total Number of Items		19

Source: Adapted from Mat Rahim (2021) and Napiah (2021)

The questionnaire was reviewed for validation by two content validity experts after completion. Such expert validation is needed here to reduce the likelihood of weaknesses present in a previously used questionnaire. Feedback from both clinical and domain experts indicated the instrument was appropriate for use. A pilot study was later carried out with 30 teachers in Selangor who matched the criteria and demographic of the sample population. This is the minimum number of pilot study responses required to conduct a full-scale test, whereby Creswell (2014) recommends at least 30 subjects be used. The Cronbach's alpha coefficient identified for CT knowledge was 0.93 and, in relation to the Perception of Implementation of CT related to problem-solving skills, it was 0.83. The Cronbach's alpha values for the pilot study are categorized under good and this means that there is high reliability in measuring the constructs studied. According to Taber (2018), a Cronbach's alpha value of 0.7 or higher is acceptable for an instrument.

Permission was obtained from the Ministry of Education (MOE) before executing the pilot study and actual research. Then, the researcher sought permission from Selangor State Education Department and then travelled to the district of Klang, visiting primary schools there for data collection. Before speaking to the Head of Mathematics, the researcher met with school administrators. The investigator explained about the study and then sent a questionnaire link to that KP. The Head of Mathematics was responsible for making the questionnaire available to all mathematics teachers in their school. One hundred and twenty-one teachers were given a single day to complete the survey online.

The data obtained were analyzed using Statistical Package for the Social Sciences (SPSS) version 29.0 by applying descriptive as well as inferential statistical techniques and tools to generate findings from this study. Descriptive statistics were calculated for the first and second research questions (mean values, standard deviation, frequency and percentage. The third research question, related to the impact of a level of CT knowledge on perspective toward implementation in problem-solving skills, was performed as follows using a correlation test.

Research Findings and Discussion

Level of Computational Thinking Knowledge in Mathematics Problem-Solving Skills among Mathematics Teachers

The level of CT knowledge in mathematics problem-solving skills was assessed using descriptive statistics. The mean Likert scale values (5 levels) of the CT knowledge construct are presented in Table 2. Mean value ranging from 1.00 to 1.80 suggests level of CT knowledge is very low. Mean value between the range of scores from 1.81 to 2.60 consists of a low level while mean value from 2.61 to 3.40 points to an average level. Mean values of 3.41 to 4.20 indicate high and between 4.21 to 5.00 very high level.

Table 2
Mean Likert Scale Values for CT Knowledge Construct

Mean Value	Interpretation
1.00-1.80	Very Low
1.81-2.60	Low
2.61-3.40	Moderate
3.41-4.20	High
4 21-5.00	Very High

Source: Ghazali and Sufean (2021)

The level of CT knowledge in Table 3 was analyzed descriptively according to the mean and standard deviation. The study’s results show that the knowledge level of CT has a mean of 3.24 and a standard deviation of 0.518. According to Table 2, this mean indicates a moderate knowledge level of CT. The minimum recorded value was 3, while the maximum was 5.

Table 3
Descriptive Analysis of CT Knowledge Construct

Descriptive Analysis	Mean	Standard Deviation	Minimum	Maximum
Value	3.24	.518	3	5

Further analysis of this variable was also based on frequency and percentage values. As presented in Table 4, the moderate level of CT knowledge is characteristics for 38.8% of mathematics teachers in the Klang district. In turn, 38% of teachers are viewed as having a high level of CT knowledge. The analysis has shown that the lower, very high, and very low levels of CT knowledge are observed in 19%, 3.3%, and 0.8% of teachers, respectively. This way, it is possible to note that most mathematics teachers in the Klang district have either moderate or high CT knowledge.

Table 4
Frequency and Percentage of CT Knowledge by Level

Variable	Level	Frequency	Percentage (%)
CT Knowledge	Very High	4	3.3
	High	46	38.0
	Moderate	47	38.8
	Low	23	19
	Very Low	1	.8

Table 5 presents the percentage of CT knowledge based on item. In this research, CT knowledge distribution was assessed by five items. As shown in Table 5, the highest percentage was "disagree" for both the item B2, "I can explain the decomposition technique in CT," and item B3, "I can explain the Abstraction technique in CT," with 46.3%. Four selected items were chosen as "strongly disagree" with the lowest percentage by 0.8%. Consequently, item B1, "I can explain the meaning of computational thinking (CT), and B7 "I can explain the generalization technique in problem-solving," were chosen as "strongly disagree." Similarly, item B5, "I can explain the abstraction technique in problem-solving" and B8, "I can explain the algorithms technique in CT," were chosen as "strongly agree." In overall, it could be inferred that many teachers of mathematics were "disagree" on each item in this aspect.

Table 5
Descriptive Analysis of CT Knowledge Items

No Item	Statement	Respondents Percent (%)				
		SD	D	LD	A	SA
B1	I can explain the meaning of computational thinking (CT).	.8	13.2	43.8	38.8	3.3
B2	I can explain the decomposition technique in CT.	1.7	15.7	46.3	33.9	2.5
B3	I can explain the decomposition technique in problem-solving.	1.7	19.0	43.8	32.2	3.3
B4	I can explain the abstraction technique in CT.	1.7	17.4	46.3	33.1	1.7
B5	I can explain the abstraction technique in problem-solving.	2.5	17.4	43.0	36.4	.8
B6	I can explain the generalization technique in CT.	1.7	14.9	43.8	37.2	2.5
B7	I can explain the generalization technique in problem-solving.	.8	18.2	45.5	33.9	1.7
B8	I can explain the algorithms technique in CT.	1.7	15.7	43.0	38.8	.8
B9	I can explain the results and uses of the algorithms technique in problem-solving.	1.7	15.7	41.3	39.7	1.7
B10	I can explain that CT is one of the problem-solving skills.	0	9.9	39.7	39.7	10.7

SD = Strongly Disagree, D = Disagree, LD = Low Disagree, A = Agree, SA = Strongly Agree

One of the factors influencing how mathematics teachers perceive and integrate problem-solving skills in their teaching is based on a correct understanding on CT knowledge. But a minority displayed low and very low levels. This highlights the importance of improving CT knowledge among educators. This result is consistent with Humble and Mozelius's (2023) investigation which contends that mathematics teachers' apprehensions of CT are predicated upon an appropriate level of knowledge in relation to CT. Preliminary understanding helps to prevent teachers having a negative response from the implementation of CT in education for problem-solving skills.

However, the understanding of CT in primary mathematics teachers is currently still at a moderate level. The conclusion is in line with the study by Napiah (2021) which found a moderate level of CT knowledge among trainee teachers for this research. CT knowledge includes definitions and conceptual understanding of each CT element. These results suggest that teachers are knowledgeable about what CT is, with some key definitions from important authorities on computing (Wan & Mohd, 2023) suggesting computational steps or methods to approach problems as the core conceptual elements of CT.

This study also illustrates that the role each aspect of CT can help shape mathematics teachers up to the level of dissecting in problem-solving skills. Results of this study showed that teachers had a moderate level of lacking on CT elements, specifically decomposition and abstraction. Generalization and algorithm are the next two elements that demonstrate moderate level of knowledge. This is in line with Soon and Mustafa (2018), who revealed that regarding all CT elements, teachers remain to have moderate scores.

Perception of Computational Thinking Implementation in Mathematics Problem-Solving Skills among Mathematics Teachers

Descriptive statistics were applied to assess the perception of CT in problem-solving skills, as in the assessment of CT knowledge. The descriptive analysis of CT implementation perception, presented in Table 6 using mean and standard deviation, indicates that the perception is at a moderate level. The mean of CT perception is 3.84 with a standard deviation of 0.518. According to Table 2, a mean between 2.61 and 3.40 is moderate. The minimum recorded is 3, whereas the maximum value is 5.

Table 6
Descriptive Analysis of CT Implementation Perception

Descriptive Analysis	Mean	Standard Deviation	Minimum	Maximum
Value	3.84	.518	3	5

The five items on the implementation perception were also assessed in terms of their distribution using respondent percentage scores. Table 7 presents the percentage scores for each item. The highest percentage was achieved for item C1, “I am interested in understanding more about CT in problem-solving skills,” as 68.6% agreed. The second highest percentage of agreement to item C4, “I like the integration of CT concepts in problem-solving skills” is 62.0%. However, only one item, C3, “I use problem-solving skills related to CT,” scored very low percentage of agreement response as 1.7%. Overall, there were indications that most mathematics teachers agreed with all items related to the perception of CT implementation in problem-solving skills.

Table 7
Descriptive Analysis of CT Implementation Perception Items

No Item	Statement	Respondents Percent (%)				
		SD	D	**LD**	**A**	**SA**
C1	I am interested in understanding more about CT in problem-solving skills.	0	0	20.7	68.6	10.7
C2	I am willing to learn new instruments/methods/technologies introduced for problem-solving using CT.	0	5.0	24.8	55.4	14.9
C3	I use problem-solving skills related to CT.	1.7	12.4	33.1	46.3	6.6
C4	I like the integration of CT concepts in problem-solving skills.	0	5.0	24.8	62.0	8.3
C5	I am interested in attending workshops/training on CT concepts to improve problem-solving skills.	0	0	15.7	66.1	18.2
C6	I am aware that mastering CT skills is very useful for my students' problem-solving abilities.	0	0.8	8.3	66.1	24.8

SD = Strongly Disagree, D = Disagree, LD = Low Disagree, A = Agree, SA = Strongly Agree

This result implies that the perceptions of mathematics teachers on CT implementation in problem-solving skills are categorized into positive and good. With respect to CT in the context of problem-solving, most teachers displayed substantial curiosity. Nonetheless, there are challenges and barriers which could influence the ongoing attraction in teachers for implementing CT (Humble & Mozelius, 2023.). This means that educators need to make an extra effort in order not to lose their inspiration. Teachers also understand the necessity of CT to improve problem-solving skills. This understanding allows those teachers to sustain the continued positive and competent provision of CT in problem-solving (Avcı & Deniz, 2022). In conclusion, the results reveal that a strong majority of mathematics teachers have interest in CT concepts as atypical problem-solving strategies. At the same time plan taxes are implemented for a problem-solving ability in students, teachers also highlight on trainings that support CT implementation into pedagogical units.

Relationship between Computational Thinking Knowledge and its Implementation Perception in Problem-Solving Skills among Primary School Mathematics Teachers

Before the inferential analysis, requirements of the Spearman Rank Correlation Test were checked. The variables were tested for normality using a statistical approach and it was observed that the data followed normal distribution. The Spearman test was employed in determining the relationship between CT knowledge and its application perception within mathematics teachers toward problem-solving skills.

According to Hair et al. (2010), there are several categories for the r-value (coefficient). The categories are as follows: a) 0.10 to 0.19 is considered very low, b) 0.20 to 0.39 is low, c) 0.4 to 0.59 is moderate, d) 0.6 to 0.79 is high, and e) 0.8 to 1.0 is very high. Table 8 shows that CT knowledge has a moderate, significantly positive linear relationship with the perception of CT implementation ($r (119) = 0.448; p <.05$). For instance, the better teachers are at CT knowledge, they tend to have increased rate of perception of implementing CT in mathematics.

Table 8
Results of the Pearson Correlation Analysis between CT Knowledge and Perception of CT Implementation

Variable	**Perception of CT Implementation**		
	N	r	**Sig**
CT Knowledge	121	0.448	0.01

* Significant p<005

Related to the third research question, findings show a statistically moderate and positive correlation between CT knowledge and perception of AI implementation. The level of CT knowledge significantly impacts the perception of its implementation in problem-solving skills (Adawi, 2021; Humble & Mozelius, 2023; Napiah, 2021; Reichert et al., 2020). This realization is key to allowing teachers to properly integrate this CT into a problem-solving oriented mindset.

The findings of this study suggest that teachers who are competent in CT have a positive perception toward implementing CT. They tend to use CT more if they have a favorable view of it. This is consistent with the results of Avcı and Deniz (2022). Improved CT literacy results in more-interested, motivated teachers, not only in math teaching and learning, but they will also make use of these competences when practicing their profession (Erdogan, 2020). This knowledge of CT gives them the belief that the use of CT can further improve their ability to teach in problem-solving-careers.

Many studies on this relationship also involve teacher trainees. In the study conducted by Napiah (2021), the level of readiness among teacher trainees was related to the perception of CT implementation. This readiness encompasses the aspects of knowledge, skills, and attitudes toward CT in various teacher trainees, namely mathematics trainees of public universities. On the other hand, in the study conducted by Soon and Mustafa (2018), no significant relationship was found between the CT knowledge and the achievements of mathematics teacher trainees of IPGs. This indicates that other concerns also affect the perception of trainees in using CT in problem-solving skills. The achievements of IPG teacher trainees only demonstrate a weak relationship with CT knowledge and skills

Conclusion

The results thus show that knowledge of CT is on a moderate to good talent level among teachers in the Klang district. In addition to this, a significant relationship of the level of CT knowledge and its implementation in problem-solving skills was determined. The perception to make use of CT principles and effective learning in the development requires a positive incentive, which is why teachers should have an adequate level of knowledge regarding the same for transfer into problem solving skills. We explored creating support for math educators to better understand and utilize the application of CT in problem-solving skills. More importantly, teachers serve as facilitators to children and ensure that they acquire the different competencies, resulting in successful mathematical problem-solving. The teacher also appears as an agent of change in the curriculum, which seeks to create a generation able to face current and future challenges.

Recommendations

According to the findings, several recommendations are suggested. Such possibilities are to extend the study of other mathematics teachers in secondary schools or to investigate students per se and subsequently with different samples. In addition, other studies with the same problem of interest used different analyses but were consistent with the aims. The investigation concentrated only on the link between CT knowledge and skills in terms of problem-solving perception using a special nature (knowledge, comprehension). This study has helped face some issues and future research might consider different teaching styles.

Implications

The results of this study could be a valuable resource that can benefit the broader literature in problem solving. Knowledge and skills in CT were found to be associated with the perception of their implementation. These findings have implications for various stakeholders, including teachers, students, schools, state education departments, and the Ministry of Education Malaysia. Positive perceptions of CT implementation in problem-solving skills will broaden the horizons for teachers to improve their practice, especially with new pedagogy. It is understood that it would facilitate more flexible and experiential learning, matching 21st century expectations of how universities should shape their teaching to suit a new generation. The Ministry could go as far as to develop modules especially for mathematics teachers in developing their CT skills and problem-solving.

This study also adds valuable insight both theoretically and contextually to the current understanding of education, specifically in the way CT relates to teaching problem-solving in mathematics. On a theoretical level, the research deepens our grasp of how CT knowledge influences mathematics teachers' perceptions and their ability to integrate these skills into classroom practice. Contextually, the findings are particularly significant for the Malaysian education system, as they offer practical insights that can be used to enhance teacher training and curriculum design. The study focuses on primary school mathematics teachers in Klang, providing a localized perspective that highlights the importance of equipping educators with a stronger foundation in CT. It reinforces the need for more targeted professional development programs that can help teachers better understand and apply CT concepts in their teaching.

Study Limitations

The present study includes only primary school mathematics teachers in the Klang district. There are no students in this research and the current analysis does not explore other factors. Namely, the study analyzes the relationship between CT knowledge and the perception of its implementation in problem-solving. Additionally, only the factor of CT knowledge and its impact on the perception of implementation in problem-solving was investigated without the inclusion of other factors.

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