ROLE OF ATTENTIONAL CONTROL AND COMPUTATIONAL THINKING SKILLS IN MATHEMATICS ACHIEVEMENT OF ELEMENTARY STUDENTS

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Abstract
Executive function is a set of skills that governs an individual's overall cognitive control. Gaining Executive Functioning (EF) skills is essential for academic and personal success. Due to the abundance of evidence, It is clear that EFs are essential for academic and school achievement. Attentional control is considered as the most important executive functioning skills than working memory and cognitive flexibility. When we are distracted from a large task, our ability to complete it decreases. Information used to support active task goals demands attentional resources for preservation, as attention is an emergent attribute of maintaining the present task goal. The capacity to focus on a certain task while avoiding distractions is known as attentional control. The capacity to solve mathematical problems is closely linked to attentional control. Children that are better at managing their attention control have higher levels of proficiency in the classroom. The term "computational thinking" refers to the sophisticated collection of thought processes used when expressing and resolving problems using computational tools. These days, it's thought that one of the most crucial math skills is the capacity to systematise issues and solve them in this way. By enabling people to selectively concentrate on pertinent information while tuning out distractions, attentional control improves computational thinking abilities. Previous study findings revealed that mathematics achievement is related to students computational thinking skills. The present study explores the correlation of attentional control, computational thinking ability, and achievement in mathematics. Purposive sampling technique used for this survey study. 50 students (mean age is 12.2) of grade 8 selected for this study. Quantitative data collected and anlaysed. Descriptive statistical analysis were made. The study findings revealed that there is a positive relationship among attentional control, computational thinking skills and achievement in mathematics. It is also found that the girl students are having high value in attentional control and computational thinking skills than the boy students. This study suggested that incorporating attentional control strategies into the curriculum to enhance both cognitive and academic performance in mathematics.
Keywords: *Executive Functioning Skills, Attentional Control, Compuational Thinking Skills, Mathematics Achievement.*

Introduction

Mathematics is an critical component of academic instruction and it has a significant impact on pupils' cognitive and problem-solving skills. Mathematical achievement, especially in the higher elementary grades, is critical not just for future academic success

but also for everyday decision making and logical reasoning. Enhancing mathematical skills entails more than just memorising formulae and concepts; it also necessitates the development of cognitive skills that assist problem-solving, critical thinking, and the ability to handle difficult activities. Attentional Control and Computational thinking are the two main cognitive abilities that support success in mathematics. The cognitive capacity to focus on pertinent information and limiting irrelevant matters while doing tasks is known as attentional control. On the other hand, pupils that possess computational thinking skills are able to reconstruct problems identify patterns, and approach problems logically and systematically. Executive functions (EFs) and attentional control (AC) become increasingly critical in children's successful navigation of their school settings and everyday activities in their homes (Best et al., 2009; Diamond, 2016; Garon et al., 2008). AC is closely linked to EFs, acting as both a foundation upon which EF components are built and an ongoing process that is critical for EF development (Garon et al., 2008). According to research, attentional control is a strong predictor of mathematical problem-solving abilities. Students who have greater attentional control do better on activities that demand sustained concentration and the ability to suppress unnecessary information, both of which are necessary for sophisticated problem solving in mathematics (Blair & Razza, 2007). Computational thinking has been discovered to give a good foundation for acquiring and implementing mathematical concepts (Grover & Pea, 2013). This study conducted with the aim to find out the relationship between Attentional control, Computational Thinking skills and Achievement in Mathematics of elementary level students.

Attentional Control

Attention is commonly thought to serve three primary purposes in cognitive neuroscience: (1) modulation of arousal, alertness, and attentional engagement; (2) stimulus selection; and (3) attentional control mechanisms. Attentional control, or the ability to balance competing attentional demands, plays an important role in children's daily lives. This executive attention system integrates executive, attentive, and memory functions. The primary goal of this system is to process, maintain, and revise any information relevant to the current activity while discarding irrelevant information. Inattention, particularly during daily functioning, can result in long-term deficits that diminish task completion and practice in learning circumstances, thereby affecting academic achievement (Pfiffner et al., 2014). Executive functions including attentional control, working memory, and cognitive flexibility are closely related to mathematics achievement. A strong executive function, particularly attentional control help students maintain focus during problem solving tasks, manage multiple steps, and adapt to changing demands in mathematics (Bull & Scerif, G. 2001).

Computational Thinking Skills

Although there is no universally accepted definition of Computational Thinking (Román-González et al., 2018), it can be broadly described as a process of thinking and a tool for solving problems using computer concepts, either with a computer (plugged-in) or without one (unplugged). According to Wing (2006), Computational Thinking is not only used by computer scientists but also by anyone with basic problem-solving skills. According to Curzon et al. (2009), computational thinking is a necessary skill for the 21st century. Computational thinking involves skills such as task decomposition, pattern identification, abstraction, and algorithmic problem solving (Exploring Computational Thinking, 2015).In mathematics, computational thinking skills involve dividing complex problems into smaller, easier-to-manage pieces and coming up with answers. Executive functioning, which encompasses cognitive functions including working memory, cognitive flexibility, and inhibitory control, is closely related to these skills. Training in computational thinking has been shown to enhance executive functioning capabilities, including planning and visuo spatial working memory, which in turn enhances cognitive performance. Computational thinking has been proven to be tightly linked to cognitive processes such as executive functioning. The study by C. Robledo-Castro in 2023 suggests that training in computational thinking for school children has positive effects on their cognitive abilities. Specifically, this training improved their performance in visuo spatial working memory (the ability to hold and manipulate visual and spatial information), sequential planning (organizing tasks in a logical order), and overall cognitive skills. The statement discusses a work by J. Robertson from 2020, which has been cited 42 times. It explains the connection between executive functions—mental processes that help regulate thoughts and behaviors—and elements of computational thinking, which involves problem-solving and systematic reasoning. The author also presents preliminary research data to support these ideas.

Review of Literature

In mathematics, computational thinking and attentional control are strongly intertwined, especially when it comes to problem-solving. Focus and concentration: By exercising attentional control, students may stay focused and pay attention when working on CT tasks like problem-solving and algorithm construction. **Bialystok (1999)** conducted research on "Cognitive Complexity and Attentional Control in the Bilingual Mind". The study's findings showed that children with math difficulties also have problems with their attentional networks and numerical abilities. **Swanson (2011)** made a longitudinal study on working memory, attention and mathematical problem solving of elementary school children. the study findings revealed that Attentional control plays a key role in basic arithmetics operations . Students who can effectively manage their attention tend to make fewer errors arithmetic tasks, perform calculations more efficiently, and are better at switching between different types of mathematical problems. **Cueli et al. (2020)** Attention, inhibitory control, and early mathematical ability in preschool children.The purpose of this

study was to better understand the relationship between EFS (attention and inhibitory control) and numerical mathematics ability in preschoolers. The revised Early Numeracy Test (ENT-R) and Continuous Performance Test examined attention and inhibitory control. The findings are: The response time of attention predicts numerical mathematics ability. The findings emphasise the importance of attention in preschool pupils' numerical skills, with a stronger emphasis on response time, which is better in students with higher numerical mathematics skills. **Zakaria and Iksan (2020)** studied about Computational thinking among high school students. They found that Female students demonstrate stronger CT skills than male students. There is no significant variation in computational thinking based on parents' educational levels. **Chongo et al. (2020)** investigated the level of computational thinking skills among secondary science students: variation by gender and mathematics achievement. They discovered that the kids' Computational Thinking abilities were at an honours level. There was a statistically significant relationship between computational thinking skills and arithmetic achievement, but there were no significant gender differences in CT skills. According to **Hyde et al. (1990)** made a meta analysis study on Gender differences in mathematics performance and the study findings revealed that Girls often demonstrate higher attentional control and better problem-solving approaches, leading to better performance in math, particularly in areas that require higher-order thinking and sustained concentration. **Shute et al. (2017)** studied about Demystifying Compuational thinking and the research indicates that students exposed to computational thinking framework develop stronger analytical skills, which translates into better performance in mathematics, particularly in complex problem-solving scenarios.

Research Questions

- What is the level of awareness of attentional control among elementary level students?
- What is the level of awareness of computational thinking skills among elementary level students?
- What is the difference between boys and girls in attentional control?
- What is the difference between boys and girls in computational thinking skills?
- What is the relationship among computational thinking skills, attentional control and achievement in mathematics?

Objectives of the Study

- To find the percentage level of attentional control, computational thinking skills and achievement in mathematics among elementary level students.
- To find the difference between the boys and girls in their attentional control.
- To find the difference between the boys and girls in their computational thinking skills.

- To find the relationship among attentional control and computational thinking skills and achievement in mathematics.

Methodology

- **Population and Sample:** 50 students (Boys- 27 and Girls- 23) from a Government Aided High school from the grade-8 selected for this study.
- **Sampling Procedure:** Purposive random sampling technique adopted to select the samples.

Tools Used

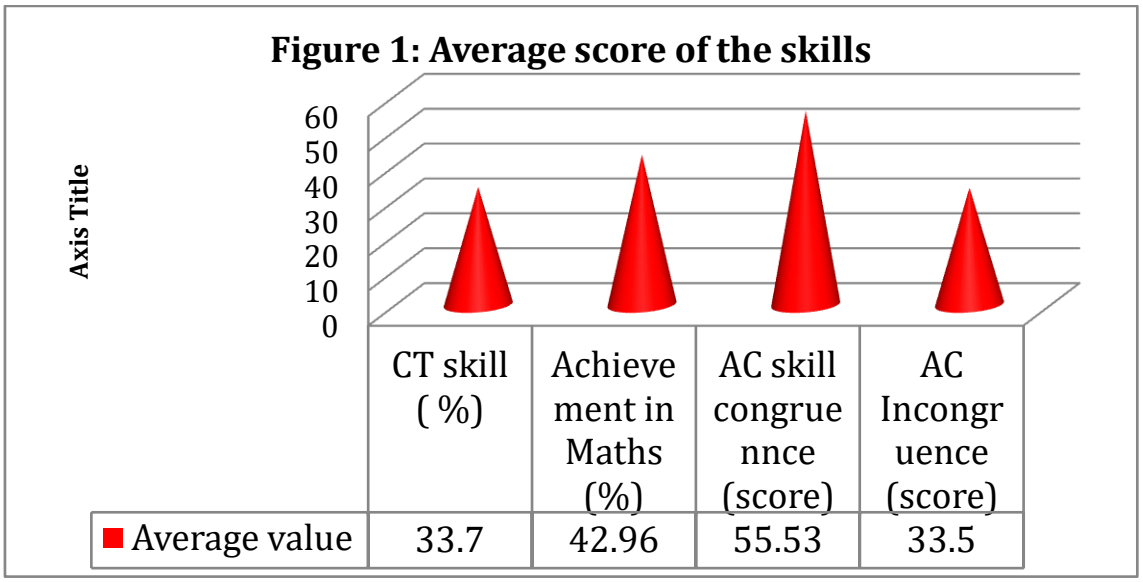
Attentional Control Assessed by Stroop Task: The stroop task is used to evaluate attentional control. The psychologist John Ridley Stroop, who first recognized the phenomenon in his doctoral work in the 1930s, is credited with creating the "Stroop Test" or "Stroop Effect." The task's difficulty lies in concentrating on one aspect (language) while ignoring another (color). Colour words are displayed in the congruent mode (e.g. the word 'red' written in a red colour) or the incongruent mode (e.g. the word 'red' written in a different colour). When using the incongruent mode, students are instructed to read words in a column and identify the color they are written in (Imbrosciano, A., & Berlach, R.G. (2005)). A neuropsychological test called the Stroop Color and Word Test (SCWT) is widely used to evaluate a person's capacity to prevent cognitive interference, also known as the Stroop Effect, which happens when processing one stimulus attribute interferes with processing another (Scarpina, F. & Tagini, S., 2017).

Computational thinking skills assessed by a Mathematics worksheets contains 10 short answer type questions (each question carries two marks) from Algebra to simplify the expressions which are in like terms by using the Distributive property test the CT skills of decomposition, logical thinking, abstraction. Computational worksheets enhance problem solving abilities in mathematics (Afif, M, 2022)

Achievement in Mathematics: Students Mid-Term examination in Mathematics marks was collected from the School to consider their achievement in Mathematics.

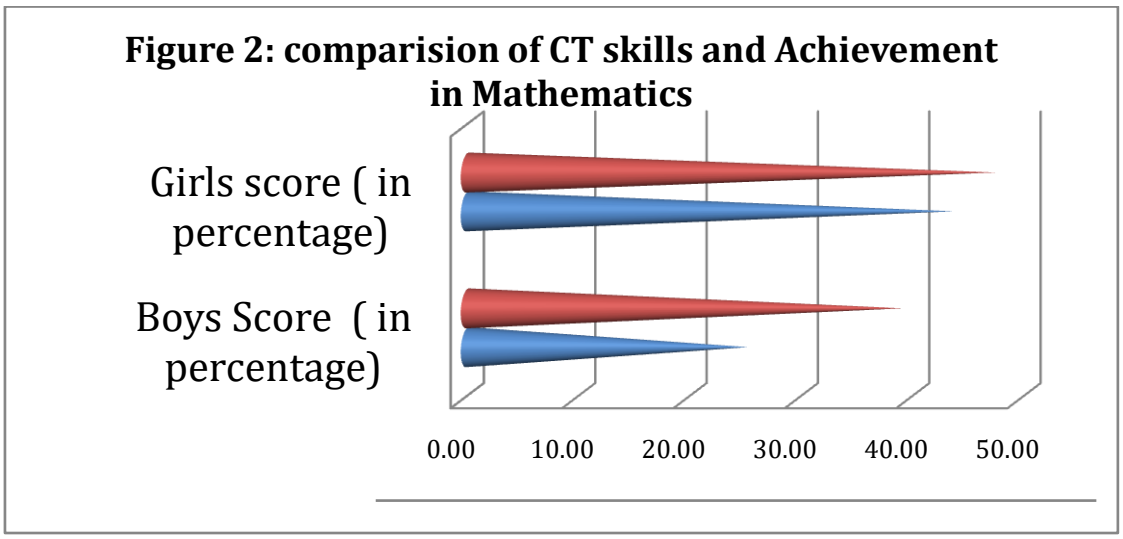
Statistical Analysis Made: Percentage analysis and Descriptive statistical analysis were made.

Finding 1



From the figure 1, It is inferred that the overall percentage of computational thinking skill is only 33.7 % and the Student Achievement in Mathematics is 42.96 % . And, It is also found that students scored value in Incongruence task is less than the Congruence task.

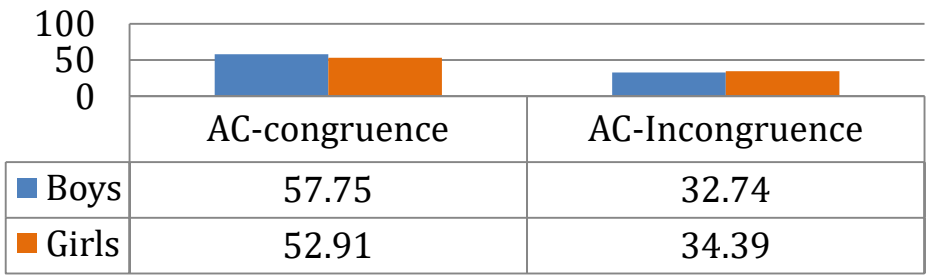
Finding 2



From the figure 2, It is revealed that The Girls are having higher value than the Boys in Computational thinking skills and Achievement in Mathematics.

Finding 3

Figure 3. Attentional control - Boys Vs Girls



From the figure 3, It is found that Boys are having high score in Attentional control - congruence task but they are having lower value in Incongruence task compare to girls. The findings reflect that Girls are having better Attentional control than boys comparing the interference score of both boys and girls.

Finding 4

Table 1 Difference Between the Boys and Girls in Compuational Thinking Skills, Attentional Control Tasks and Achievement in Mathematics

Variables	Gender	N	Mean	S.D	p-value	L.S
CT skills	Boys	27	25.18	14.96	**Less than 0.0001**	**Sig.**
	Girls	23	43.69	13.91		
Attentional control (Congruence)	Boys	27	57.75	13.58	**0.168**	**N.S**
	Girls	23	52.91	10.31		
Attentional control (Incongruence)	Boys	27	32.74	8.66	**0.530**	**N.S**
	Girls	23	34.39	9.78		
Attentional control Interference	Boys	27	25.01	10.22	**0.025**	**Sig.**
	Girls	23	18.52	9.45		
Achievement in mathematics	Boys	27	39.11	17.74	**0.07**	**N.S**
	Girls	23	47.47	14.60		

From the Table 1, It is interpreted that there is a significant Difference between boys and girls in Computational thinking skills and Attentional Control Interference. There is no significant difference between boys and girls in Attentional control congruence, Attentional control Interference and Achievement in Mathematics.

Finding: 5

Table 2. Correlation Value among variables:

Variables	CT skills	Achievement in Maths	Attentional control
CT skills	1.00	0.478	**0.273**
Achievement in Maths	0.478	1.00	**0.410**
Attentional control	0.273	0.410	**1.00**

From the table 2, we found that There is a Moderate value of Positive Relationship between Computational thinking skills and Achievement in Mathematics of elementary level of students. There is a low positive correlation between Computational thinking skill and Attentional control of elementary level of students. There is a Moderate value of Positive correlation between Attentional control and Achievement in Mathematics of elementary level students.

Overall Findings

- The findings of the study indicated that compared with boys girls reported higher computational thinking performance. This finding supports previous study findings that Gender differences found and female students show higher computational thinking skill ability (zakaria. N.I, Iksan. Z, 2020 , Li.Q.et al., 2024)
- In mathematics achievement, girls are secured higher values than boys. This study findings contradictory to previous research findings of Fennema and Eamon (1990), Mullis et.al (1997) and NCERT (2012) who found no significant difference between girls and boys on mathematics achievement.
- There is a positive relationship among Attentional control, Computational thinking skills and Achievement in mathematics of elementary level students.
- The majority of studies on computational thinking focused solely on computer science. As a result, greater research and awareness are needed regarding computational thinking skills and their usefulness in mathematics.

Implications

Because computational thinking is still in its early stages, the majority of teachers, particularly those in government schools, are unaware of it. In this study Overall score of Computational thinking skills in Mathematics score is very less indicates that there is a need to develop the Computational thinking skills among students. School should consider incorporating more Problem solving and logical thinking activities into daily teaching , especially in mathematics, to enhance computational thinking.

The findings that girls outperform boys in Computational thinking skills, attentional control and mathematics achievement suggests that gender related factors, such as learning styles motivation, or classroom dynamics, might play a role. Educators can use this information to tailor teaching strategies that support both genders.

From the findings it is found that there is a Positive relationship among Attentional control, Computational thinking skills and Achievement in Mathematics. It reflects the strong link between attentional control and academic success. Teachers should include activities that enhance concentration and attention in the classroom.

Limitations

This study considered only the elementary level students and the sample selected from one school only. Differential studies considered only the gender difference but not for their socio- economical status.

Scope for Future Study

Longitudinal studies could track the development of computational thinking skills, attentional control, and mathematics achievement over several years to understand how these skills evolve and how early interventions can impact long-term performance.

Intervention Based research studies that suggest specific Interventions to improve Compuational thinking and Attentional control will be helpful for future.

Conclusion

This study examines the relationship between attentional control, Computational thinking skills and academic achievement in elmentary level students. The findings indicated that girls have secured higher value than boys in computational thinking skills and achievement in mathematics. This highlights the valuable impact of evolving educational approaches and social influences on gender disparities in STEM-related. It is also found that there is a strong correlation between computational thinking skill achievement in mathematics, teachers should intentionally incorporate computational thinking activities and strategies into mathematics education. Further research will help to identify the approaches to enriching student's Computational thinking.

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