

Computational thinking learning concepts for elementary school students in face-to-face and distance education

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In recent years, several researchers have proposed frameworks to assess students' Computational Thinking (CT) level (Rachmatullah et al., 2020; Silva et al., 2020). The purpose of this poster is to show how early years students used CT to explore mathematical ideas while programming a dinosaur gameⁱ with Scratch. Their mathematical learning outcomes were highlighted in Dobgenski & Brito Prado (2023) and the CT concepts will be analyzed by Silva et al. (2020) and by Rachmatullah et al. (2020) frameworks which were combined in this research.

Theoretical framework

For this study we follow CT's definition proposed by Selby and Woollard (2013, pp. 5) which considers CT as "a focused approach to problem solving, incorporating thought processes that utilize abstraction, decomposition, algorithmic design, evaluation, and generalizations". Rachmatullah et al. (2020) developed a Concept Inventory (CI) using a block-based programming language with 24 multiple-choice items guided by knowledge, skills, and abilities focused on programming/CT concepts as variables, loops, conditionals, and algorithms. Silva et al. (2020) investigated students' CT in mathematics education analyzing teaching experiments and using a framework based on constructionism and problem solving. They considered user-computer interaction as description-execution-reflection-debugging-description... spiral actions for constructionism, and for problem-solving suggesting heuristics components such as exploring, planning, verifying, and analyzing.

Methodology

We analyzed the activities developed by two primary school students, one being at that time 9 years old in Grade 4 and had face-to-face meetings and the other 10 years old in Grade 5 and had remote meetings. Both had 1-hour sessions per week for 2 months in 2021 to carry out programming activities in Scratch. The goal was to develop a game like Google Chrome's dinosaur game. Data were collected from students' protocols, training video recordings, and the Scratch programming code developed. Data were analyzed according to the CT definition presented and the pupils' CT concepts were highlighted by analyzing the students' codes using the frameworks by Silva et al. (2020) and Rachmatullah et al. (2020).

Statement and results

Figure 1 shows both frameworks considered in this study and the students' roles while developing their own codes to solve a problem. Figure 2 presents an illustration of coding for a remote student, where the challenge was to create the movement of obstacles in the game. The Silva et al (2020) framework is explored in the 2nd to 4th columns, and the last column displays the CT concepts utilized in the Rachmatullah et al framework.

Silva et al. (2020) Constructionism Problem Solving (learning Spiral) (Heuristics)		Student's role	Rachmatullah et al. (2020) CT Concepts (algorithms, loops, conditional, data)
Debugging	Exploring	They reread to better understand the problem.	All of them may be included in these activities, depending on the nature of the task programmed.
Description	Planning	They combine different strategies to solve a problem.	
Execution	Verifying	They write a code to share possible solution.	
Reflection	Analyzing	Based on code's outcome they compare the results	
Debugging	Exploring	They read again, if the results are not the desired one.	

Figure 1: The students' roles based on Silva et al framework.


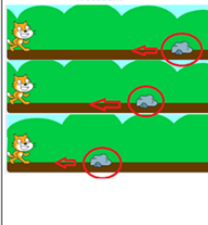
Problem/Solution	Silva's Framework			Rachmatullah's Framework
	Debugging (Exploring) Reflection (Analyzing)	Description (Planning)	Execution (Verifying)	CT Concepts
<p>Problem: Programming the obstacle movement always moving from right to left of scenario side.</p> <p>Solution: They decreased the obstacle steps and when the obstacle touched the left edge the students changed its position to the right edge beginning.</p>	<p>R student</p> <p>Teacher: Why didn't the rocks' movement from right to left work? [The student repeated the code he used to make it move from left to right].</p> <p>R student: I don't know.</p> <p>Teacher: When the rock is in this position, is their horizontal location greater or smaller than that other one? [Indicating the movement of the rock and its x location from right to left].</p> <p>R student: The x was 235 and now is -153, that is smaller.</p> <p>Teacher: What do you need to do to decrease the x location.</p> <p>R student: I'll setup the "move" command to zero. [He tried and failed].</p> <p>Teacher: Is there a movement with zero?</p> <p>R student: [No] I'll use minus twenty (-20). [With this changing the rock move correctly, but fast].</p>	<p>R student</p> 	 <p>Data: "move -5 steps" "go to x: 207 y: -144" "go to x: 213 y: -108"</p> <p>Conditional: "if touching edge? then"</p> <p>Loop: Forever Move... If... Go to x... End</p> <p>Algorithm: When... Forever</p>	

Figure 2: R Student's code interpreted by Silva et al (2020) and Rachmatullah et al (2020) frameworks.

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ⁱ The game involves guiding a dinosaur to jump over obstacles displayed on the screen. To play, type `chrome://dino/` in a Chrome browser.