ROLE OF UNDERSTANDING OF MATHEMATICAL CONCEPTS IN THE CONTEXT OF DEBUGGING COMPUTER CODES

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Introduction

Some authors say that we are now witnessing a revolution in industry (industry 4.0) and the emergence of a society (society 5.0) based more on the most recent digital developments (Gregório et al., 2020 Roblek et al., 2020). In these socio-economic transformations, the use of the Internet of Things (IoT), cyber-physical systems (CPS) and related technologies grow in importance. Thus, educating students in core topics in electronics, circuits, and embedded system design is becoming increasingly relevant in school (Karchemsky et al. 2019). A complexity of tasks places students in novel situation in which an ability to debug is one of the key aspects of the development of their problem-solving skills (Przybylla and Romeike, 2018; Nouri et al., 2018; Wing, 2006). In such situations, mathematical concepts play a particular role which needs to be investigated in more depth.

Today, K-12 schools engage students in a variety of Science, Technology, Engineering, and Mathematics (STEM)-oriented projects, some in special learning environments (makerspaces, fablabs, etc.) which include, among others, coding and physical computing. For instance, they can use block-based programming (MakeCode, MIT Scratch, Greenfoot) and physical computing with embedded systems (Arduino, LEGO Micro:Bit, Mindstorm) to create their independent projects (Schneider et al., 2020). In the coding of CPS, they use block code which requiring several mathematical concepts such as: patterns (including number sequences), geometrical concepts (triangle, circle, etc.), arithmetical concepts, rotation (Bråting and Kilhamn, 2021). They use debugging to fix errors and problems that occur in their creation (Booth et al., 2016; Fields et al., 2021).

In our MACAS presentation, we analyze some data from NB, Canada, students projects to understand how students debug errors and problems by applying math concepts and operations during the creation of physical objects in technology-rich school environments.

Debugging by applying Mathematics concepts and values

Debugging, considered as a process of identifying and fixing errors in code (Michaeli and Romeik 2019*)*, remains difficult and challenging process for many elementary school students who use both coding platform and physical computing devices (PCD) (Booth et al., 2016; Fields et al., 2021; Przybylla & Romeike, 2018).

According to Macann and Carvalho (2021, p.229), there seems to be a consensus regarding the argument that debugging constitutes one of the components of computational thinking (CT).

CT has been defined by Cuny, Snyder, and Wing and Wing (2010, p.1) as “the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent”. Yadav et al. (2017, p. 56) have proposed the definition of CT as “a set of problem-solving thought processes derived from computer science but applicable in any domain”.

Freiman et al. (2018) argue that there is a relationship between CT, mathematical thinking, mathematics although its nature is not yet well understood. Shute et al. (2017, p.4) explain that “Mathematical thinking consists of three parts: beliefs about math, problem solving processes, and justification for solutions". In point of view of Wing (2008), "the main commonality between CT and mathematical thinking is problem solving processes" (Shute et al., 2017, p.4). Macann and Carvalho (2021, p.139) argue that CT is explicitly linked the learning of mathematics activities that are related to multiplication, charting information, finding square roots. According to Kilhamn et al. (2021), when students engage in CT practices such as debugging, they can learn or apply mathematics concepts.

In New Brunswick, several schools offer opportunities for students to learn coding and PCD to carry out independent projects related to the creation of physical objects in technology-rich environments, such as makerspaces (Freiman, 2020). In this digital creation, students face code errors and problems of all kinds, often unpredictable, which can prevent their programs and PCD from functioning properly (Freiman and Kamba, 2021).

They make errors or bugs related to, among others, the time value in the pause code block, the degree of rotation value in the movement (turn) code block, the distance value in the code block movement (forward and backward) as well as the repeat value in the loop code block. Students must debug their program by applying math concepts and operations related to measurement, rotation, distance, speed, and geometry.

Our communication shares some of the first results of a doctoral study, still in progress, aiming to present the state of the problem related to students' debugging practices during the realization of various creative projects that involve coding with the use various physical computing devices. It specifically reflects on the application of Mathematical concept and value to debug errors and problems when creating physical objects in school-based STEM lab.

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