

# Examining the Use of Computational Thinking Skills When Solving Bebras Tasks

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## ABSTRACT

Computational thinking (CT) is considered an essential problem-solving skill in the 21st century, and is receiving attention on different educational levels. To promote and assess students' CT skills, so-called 'Bebras tasks' (i.e. small tasks for problem solving in informatics) are created by experts in the field of CT. There has not been empirical research to determine to what extent and how CT skills are used while solving these tasks, however. This qualitative study bridges this gap by using the think-aloud method to examine the use of CT skills when solving Bebras. The results of this study can serve as a validation for the use of CT skills in solving Bebras tasks. This poster abstract introduces the background and setup of the study.

## CCS CONCEPTS

• **Social and professional topics** → **Computational thinking.**

## KEYWORDS

computational thinking, Bebras, think-aloud

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## 1 INTRODUCTION

Due to the prevalence of computational tools in current society, supporting the development of Computational Thinking (CT) skills has been an important topic in different levels of education. CT concerns "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" [18]. Although different classifications exist, five skills are often identified as part of CT: abstraction, algorithmic thinking, decomposition, evaluation and generalisation [16]. To introduce these concepts in primary and secondary education, yearly Bebras Computing Challenges are organised in different countries. In these

challenges, students are presented with a number of puzzles also known as Bebras tasks. Over the years the scope of the tasks has evolved, and they are also used outside of the challenges. It has been suggested that the Bebras can be used to track students' progress as they develop their CT skills [5]. The actual use of CT skills while solving the puzzles has not been studied, however. This means that, even though the puzzles are created to stimulate and sometimes evaluate the use of CT skills, there is currently no evidence that the skills are actually used while solving the tasks. We aim to bridge this gap by examining the process of solving the tasks qualitatively using the think-aloud method.

## 2 BEBRAS TASKS AND COMPUTATIONAL THINKING SKILLS

The Bebras tasks comprise of small logical puzzles. The tasks are created by experts in the field of CT during the International Bebras Tasks Workshop. Experts not involved in the creation of the tasks review them to determine the difficulty level and the CT skills targeted by the task [4]. The difficulty level of the tasks has been confirmed through studies [6], and in some studies experts are asked to assign applicable CT skills to tasks (e.g. [10]). There are no studies that confirm to what extent CT skills are actually used by problem-solvers when solving a Bebras task, however. Performance on Bebras tasks (and thus of the CT skills) is mostly evaluated by examining the outcome of the problem-solving process: the answer given. This does not provide insight into the actual use of the skills. Some of the Bebras are multiple choice questions, and taking the answers on these questions as a proxy for knowledge or skills can be misleading, as Chiodini and Hauswirth [3] demonstrated. Answering a question correctly does not necessarily mean a skill has been used. For the Bebras, a correct answer could be a lucky guess, or one might give the correct answer without using the CT skills. This also means giving a wrong answer does not necessarily mean someone is lacking CT skills. An incorrect answer could be the result of not understanding the question correctly, even though CT skills are used in the problem-solving process. If the goal of the tasks is to help problem-solvers develop their skills, or to assess the current skill level of a student, it might be better to look at the problem-solving process instead of the outcome.

## 3 THINK-ALoud AND COMPUTATIONAL THINKING

We will use the think-aloud method to examine the process of solving Bebras tasks. Think-aloud is a commonly used method to investigate problem-solving. Asking problem solvers to verbalize their thoughts can provide clear insight into the procedure and

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strategies used [17]. The use of think-aloud to investigate CT skills has been suggested in the past [7, 11, 13, 14], and some studies have shown the use of CT skills can be demonstrated by investigating think-aloud transcripts [1, 2, 8, 12]. One could question whether the think-aloud method in any way influences the problem-solving abilities (and thus may promote or hinder the use of CT skills) of problem solvers. Explaining your thinking process out loud might lead to extra reflection which leads to better performance on the task. Short et al. [17] investigated this, and did not find an effect of thinking out loud on problem-solving performance in an adult population. Similar results for senior high school students were found by Flaherty [9]. We therefore expect using think-aloud will not impact the performance on the Bebras tasks, and believe it is an appropriate method to use in this setting.

#### 4 SETUP OF THE STUDY

If CT skills are an integral part of the Bebras, we expect anyone with advanced CT skills to demonstrate the use of the skills when solving the tasks. It is, however, difficult to pinpoint what makes one an expert in using these skills. As the Bebras were originally designed to interest students in informatics problems, we have decided to delineate our search for experts to the areas of Information and Computing sciences. Professionals and academics with a master degree in these or related fields, or with extensive experience in these fields, will be asked to participate.

We aim to recruit 20 participants for the study. The experts will be presented with four Bebras from the 2017 UK Bebras contest. While the participants solve the tasks, they are encouraged to think out loud. They will also be provided with a tablet pc with hand-written note-taking capabilities, which they can use as scrap paper while solving the puzzles. Both the think-aloud transcripts and recordings of the tablet screen will be coded to examine the use of CT skills. Two researchers will both code 25% of the transcripts to increase reliability of the results. Then inter-rater reliability will be examined, and the coding rules will be re-calibrated by discussing differences in the coding [15]. After this calibration, each of the researchers will code half of the remaining transcripts and videos.

The results of this study can serve as a validation for the use of CT skills when solving Bebras tasks. We expect our analysis to provide valuable insight into which CT skills are used when solving the Bebras tasks. This could provide important findings for those using Bebras to teach or assess CT.

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