The Education Column

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Bebras: Inspiring Informatics Education Across the Globe

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Abstract

The Bebras challenge is an international initiative that aims to promote informatics and computational thinking concepts to students in schools. It is designed as a contest where participants solve a set of tasks that require problem-solving skills, logical reasoning, and algorithmic thinking. The challenge is open to students of various age groups, typically ranging from primary school to high school. It provides an opportunity for students to engage with informatics concepts in a fun and interactive way. The tasks are carefully designed to be intellectually stimulating and encourage students to think critically and creatively. The Bebras challenge focuses on concept-based tasks that cover a wide range of informatics topics. These tasks may involve understanding and analyzing information, algorithmic thinking and problem-solving, using computer systems effectively, recognizing patterns and structures, considering social and ethical issues related to technology, and solving puzzles.

The challenge is organized annually in countries all over world, and participating students solve tasks at different levels. The tasks are carefully crafted by teams of educators, researchers, and professionals to ensure their relevance, educational value, and suitability for the target age groups. The tasks are usually based on real-life scenarios or practical situations that require computational thinking skills to solve. Participating in the Bebras challenge offers students an opportunity to develop their computational thinking abilities, improve their problem-solving skills, and gain exposure to various aspects of informatics. It also encourages collaboration, critical thinking, and a deeper understanding of how technology impacts our daily lives. Thus, the Bebras challenge serves as a platform to engage students in computational thinking and foster their interest in informatics, laying the foundation for future studies and careers in computer science and related fields.

1 Introduction

Seven years ago, I published an article "Bringing Informatics Concepts to Children through Solving Short Tasks" about the Bebras challenge in the Bulletin of the EATS [2]. Since then, Bebras challenge has doubled in size: the number of countries now stands at 78, with more than 3 million students participating; see Figure 1.

The Bebras community consists of full members (55 countries) and provisional members (23 countries). Each year new provisional countries are applying and some of them get permission to enter (fulfilling required criteria), e.g., four countries (Azerbaijan, Paraguay, Peru, and Puerto Rico) have qualified to join the challenge this year. The provisional members need to establish the Bebras challenge in their countries by forming networks with schools, involving teachers, translating and adapting Bebras tasks, and promoting informatics education.

The main time of the Bebras challenge is the second week of November each year. Every Bebras member country plans a competition, training, and activities. Several countries in the Southern Hemisphere (Australia, Cambodia, Malaysia, New Zealand, Singapore, and South Korea) hold the main competition in March, when the school year starts, but they usually hold additional rounds in November.

In 2003, the idea of the Bebras competition was proposed. "Bebras" is Lithuanian word for "beaver," a hard-working, intelligent, goal seeking, and lively animal. In the past years, the number of Bebras participants has been notably growing. Over 3 million students from over 70 countries were involved in solving Bebras tasks world-wide each year. Slovenia had the strongest relative participation with over 30 000 students, whereas France had the highest total number of participants, nearly 0.7 million; see Figure 2.

The BETT (British Education and Training Technology), the largest education and technology event for 37 years, took place from March 29–31, 2023. The Bebras challenge was presented as one of the initiatives of Lithuanian researchers; see Figure 3.

In preparation for the BETT exhibition, a team from Vilnius University created a presentation of visual materials such as flyers, task cards and special bookmarks with short tasks; see Figure 4. The app created especially for the exhibition was particularly successful, as it allowed users to solve 10 Bebras tasks and win prizes.

Bebras is not only a contest, but also a platform for learning and discovery, allowing students to develop their problem-solving skills and deepen their knowledge in the field of informatics. This is not only beneficial for students, but also for teachers who can use Bebras tasks and resources in their teaching.

The aim of the Bebras challenge is to stimulate students' interest in computer science, to develop a deeper understanding of technology, to encourage the ability to solve algorithmic and logical problems, to develop critical thinking, programming

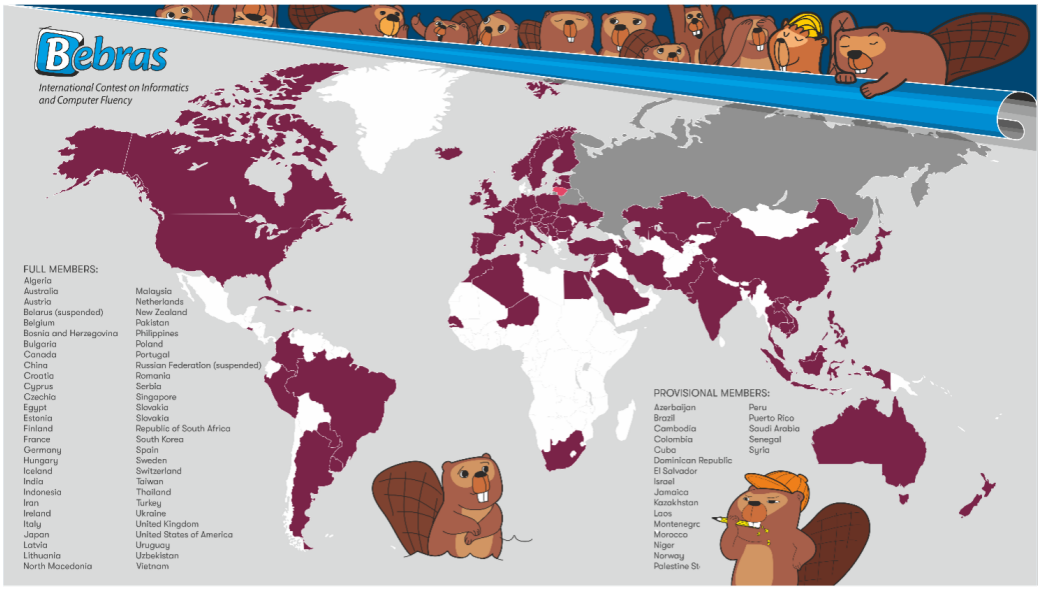

Figure 1: The Bebras challenge covers 78 countries

and computer literacy skills, and to attract more talented young people to study computer science.

Students participating in the Bebras challenge are given a wide variety of tasks, each tailored to their age group and level of logical reasoning. The appeal of Bebras tasks comes from their complexity and variety. The challenges are often complex but very interesting and require not only logical thinking but also creativity. In addition, the tasks often involve the application of various concepts and ideas that are relevant in real-world informatics. All these elements help to increase the attractiveness and relevance of the tasks, as well as to stimulate students' interest and encourage the development of computational thinking and other skills.

The competition gives students the opportunity to test their skills and creativity, as well as to expand their knowledge in the field of computer science.

The famous Finnish educator Pasi Sahlberg has highlighted the significance of playful learning, games, and gamification as factors contributing to the success of Finnish education [9]. Playful learning activities have the ability to capture children's attention and engage them in various subjects. The combination of the joy of discovery and unexpected solutions is a hallmark of such activities.

Bebras is an international initiative aiming to promote informatics among school students of all ages. The challenge is organized annually by each participating country locally. Participants are usually supervised by teachers who may integrate the Bebras tasks into their teaching activities. For running the challenge,

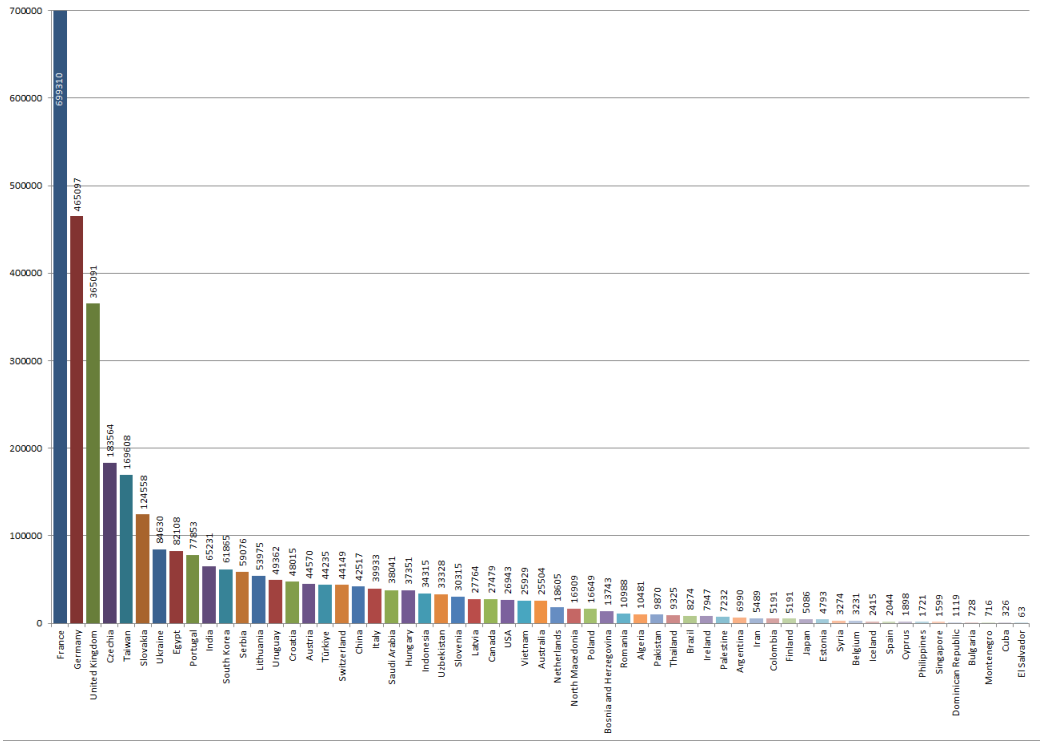

Figure 2: Number of participants in the Bebras Challenge during November 2022 and April 2023

countries use different technologies mainly based on online contest management systems (CMS). Each country chooses tasks from the Bebras task pool approved by the annually-organized international Bebras task workshop.

2 Bebras Tasks

The essence of the Bebras challenge lies in informatics concept-based tasks [1, 8]. Developing a challenging set of tasks is crucial for the success of the challenge. Task developers strive to choose interesting problems that motivate students to engage with informatics and think deeply about its core concepts. There is a need for consensus on task development criteria. Initially, six task topics were proposed: Information comprehension, algorithmic thinking, using computer systems, structures, patterns and arrangements, social, ethical, cultural, international, and legal issues, as well as puzzles [3, 10]. In recent years, a two-dimensional system for categorizing tasks has been elaborated, incorporating both informatics concepts and computational thinking skills [6].

Figure 3: At BETT exhibition: Lithuanian EdTech presents Bebras challenge

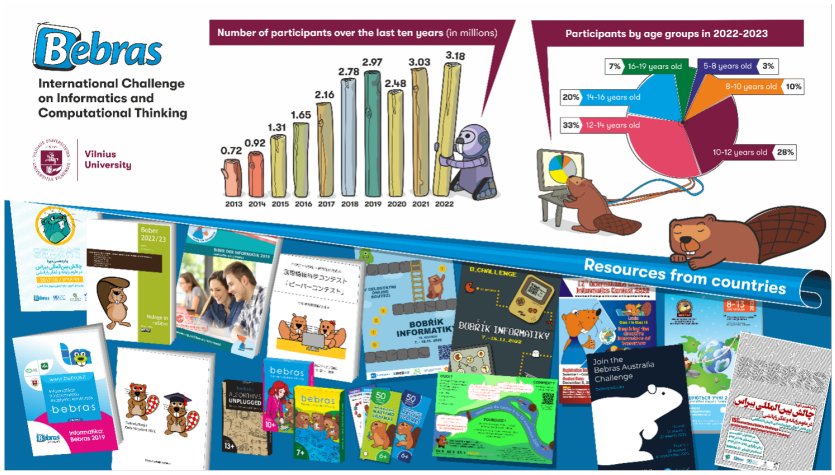

Figure 4: Variety of Bebras didactical material for teaching informatics

An annual international Bebras workshop is organized in different countries, focusing on the creation of concept-based tasks for students of all age groups. The primary objective of these workshops is to develop a set of tasks for the upcoming challenge, facilitate discussions among countries with diverse curricula

and teaching traditions, and reach a consensus on the task selection.

The challenge incorporates various types of tasks to engage participants, including interactive (dynamic) tasks, open-ended tasks, and multiple-choice tasks. The emphasis is on creating context-rich and powerful tasks that motivate and captivate students, encouraging them to delve deeper into informatics concepts. The development and introduction of such tasks pose significant challenges for researchers and educators [4, 7, 11].

Multiple-choice tasks typically feature four distinct and well-defined answer choices, with only one correct solution. Interactive tasks, on the other hand, involve a two-way transfer of information between the user and the computer. These tasks provide a problem specification, requiring students to interact directly with the computer by performing actions such as dragging and dropping objects, clicking on specific areas of pictures, manipulating objects using a keyboard, or selecting elements from a list.

Numerous countries have established networks and teams comprising researchers, teachers, and educators dedicated to the creation and discussion of Bebras tasks. These teams consistently propose new tasks each year. In the following section, four examples of Bebras tasks will be provided and discussed.

Solving short concept-based tasks is a powerful method that can support a pedagogical shift in the classroom and foster pupils' engagement and motivation to learn. Many publications deal with problem-solving methods. Solving short tasks can be one of the strategies that engage and motivate students for deeper learning and foster deeper thinking skills.

The developers of Bebras tasks are seeking to choose interesting tasks (problems) to motivate students to deal with informatics and to think deeper about technology. Also they want to cover as many informatics and computer literacy topics as possible. In informatics, there is also the problem of syllabus. Even if there is an education standard for informatics at school in some countries, until now there is no common agreement on what should be included in an integrated syllabus [5].

Example 1. Beavers vs. Kangaroos (Lithuania 2020, medium for 14–16 years)

While crossing a swamp by using a log path, five beavers meet a group of kangaroos going into the opposite direction; see Figure 5. Nobody wants to become wet or dirty so they stay on the path. The Kangaroos found out that from one specific log it is possible to jump onto a stone next to the log path and jump back to that one log. However, only one kangaroo can stand on the stone at a time.

The kangaroos and beavers don't mind going all the way back, except for Fred,

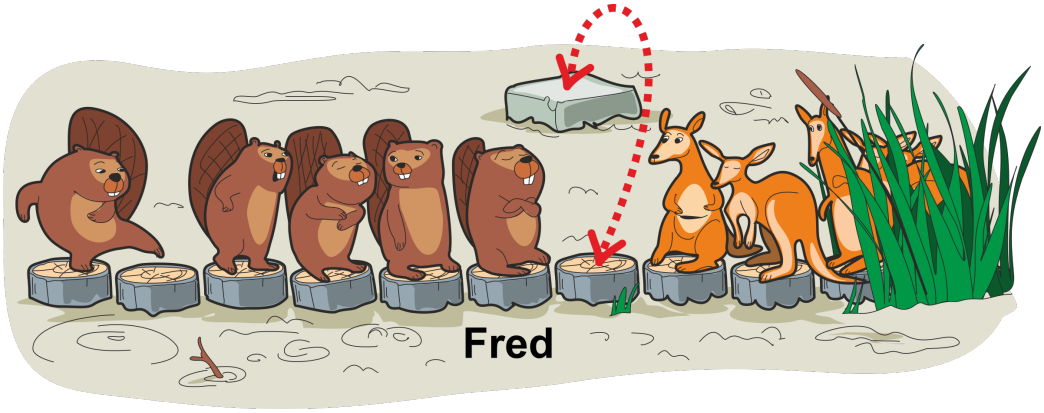

Figure 5

the leading beaver, who is the first to meet the kangaroos. Fred only wants to take a step back 10 times. With Fred's behaving this way, how many kangaroos can pass him without taking a step back?

This task introduces the design of an algorithm as a main concept including a sequence of operations (steps) and repetition, also understanding the concept of variables. Recognition of patterns in algorithms (similar steps that are repeated) can be turned into reusable code for a quick and automatic solution of a problem (as the formulation here). The logs and the stone are like registers in a processor or on a tape drive that can store data.

Example 2: Stickers (Finland 2020, medium for 16–19 years)

Betty Beaver is playing with four kinds of stickers that contain the words `ABBA`, `GAGA`, `GIBB`, and `IGGY`. She creates a word by using the stickers on an empty piece of paper. When a sticker is used at some position, it covers four characters starting from this position; see Figure 6. Betty has many stickers of each kind.

For example, one of the ways to create the word `GIABIGGYGA` would be to use the stickers as follows (asterisks indicate empty positions):

1. `GIBB` at position 1: `GIBB******`
2. `ABBA` at position 3: `GIABBA****`
3. `GAGA` at position 7: `GIABBAGAGA`
4. `IGGY` at position 5: `GIABIGGYGA`

Which of the following four words can be created by Betty's stickers? There may be several correct answers; find them all.

Figure 6

(A) `AGGIBBAGGAGABABGA`

(B) `AGGIBBAGAGGABABGA`

(C) `AGIBBGAGAGGYBAYBB`

(D) `AGGIBBAGAGGYBAGGY`

This is an example of a problem that can be analyzed using "backward induction" and "backtracking," which are common problem-solving methods in informatics. Backward induction is a process of reasoning backwards in time: we start from the end of a problem or situation (in this task, a created word), and try to determine an action (in this task, the use of some sticker) that leads to a feasible preceding situation. This is repeated until the initial situation (in this task, a completely empty state) is reached. In many problems, the process may have several possibilities for selecting actions, and in such cases the backward induction process may need to be applied in a backtracking manner: if the currently selected sequence of actions fails to reach the initial situation, then we may change some previous action selection and try again to proceed towards the initial situation.

Example 3. Strawberry Thief (Switzerland 2021, medium for 8–10 years)

Anja is playing outdoors and makes a design on the ground using four types of objects: acorns, hazelnuts, stones, and strawberries. She then adds sticks to her design according to her **Very Important Rule**:

A stick can go between two objects only if they are of different types.

Anja's completed design is shown in Figure 7. Anja's sister Zoë sees the design and eats the strawberry. To hide what she has done, she tries to replace

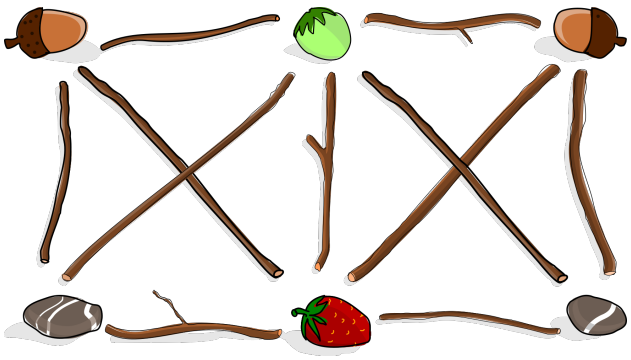

Figure 7

the strawberry with a different type of object. Which object can Zoë replace the strawberry with, without breaking Anja's **Very Important Rule**?

(A) 

(B) 

(C) 

(D) None. Only the strawberry could go there.

The correct answer is Option D. Unfortunately, Zoë is not able to replace the strawberry with a different type of object, without breaking Anja's Very Important Rule. In Anja's original design, the strawberry had sticks between it and two acorns, two stones, and one hazelnut. Changing the strawberry to anything other than another strawberry would force a stick to exist between two objects of the same type.

Anja's design can be called a graph. The objects can be called nodes and the sticks can be called edges. In a graph, edges connect nodes. Two nodes that share an edge are called neighbors. A subset of nodes where each node is a neighbor of every other node in the subset is called a clique. Anja's design contains two cliques: the left half and the right half of the design. Now suppose you wanted to assign the nodes of a graph a color so that no edges connect two nodes of the same color. Of course, the number of colors needed to do this is at least the size of the largest clique. The largest clique in Anja's design has size four, which is one reason why Zoë could not satisfy the **Very Important Rule** using just three types of objects.

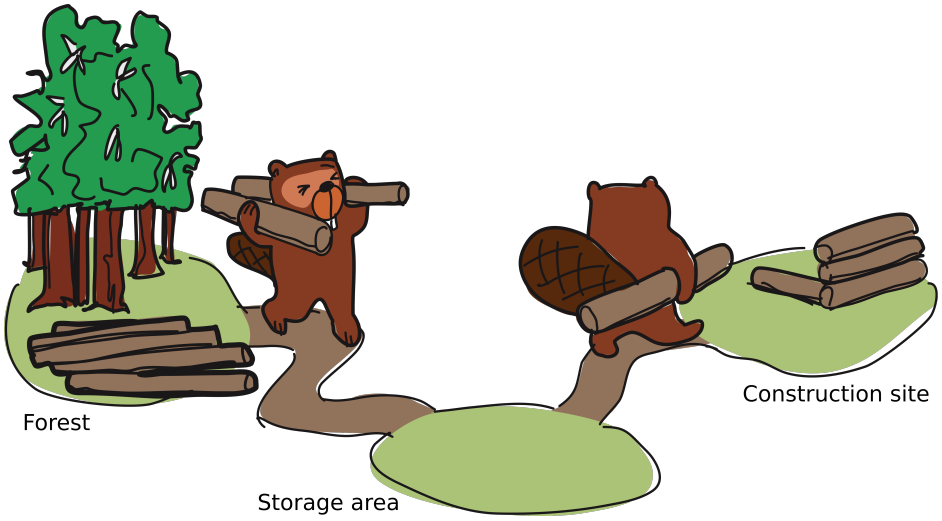

Figure 8

Example 4: Logs (Estonia 2021, medium for 14–16 years)

Jack and Sam are building a log house. Jack is bringing logs from the forest to the storage area. He can move from the forest to the storage area in 5 minutes and drag two logs at the same time. Sam is taking the logs from the storage area to the construction site. He can move from the storage area to the construction site in just 2 minutes, but only carry one log. Both beavers move at the same speed to and from the storage area with or without logs. They are working as follows:

When Jack arrives at the storage area with new logs, he will drop the logs and call out to Sam before returning to the forest; Sam will then stop working at the construction site and take the logs from the storage area.

When Sam takes the last log from the storage area and returns to the house, he will resume doing his work at the construction site; but if there are logs left at the storage area, Sam will drop the log at the house and immediately return to the storage area for more logs.

How many logs will be at most at the construction site 30 minutes after the friends start working? The way the two friends are working is similar to the producer-consumer model of parallel processing in computers. Jack is the producer of logs for Sam, and Sam is the consumer of the logs that Jack has produced.

The storage area acts as a buffer so that Jack does not have to wait until Sam comes to collect the logs; instead, Jack can return to the forest for the next pair of logs immediately and be more productive. Jack calling out to Sam when he adds new logs to the empty storage area is like the signals used in computer systems to allow one program to alert another. This lets Sam do other work instead of just

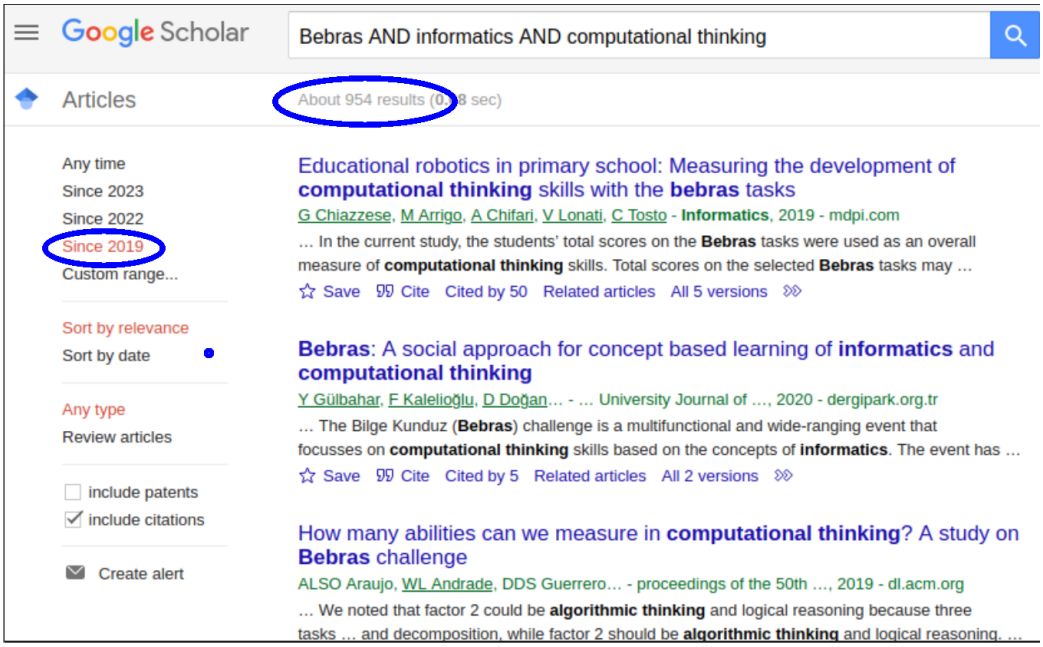

Figure 9: According to Google Scholar, 954 papers from January 2019 to May 2023 were indicated

waiting at the storage area. However, when Jack does call Sam, it takes some time for Sam to go from the construction site to the storage area, causing latency in the movement of logs. A difference of our task from the classical producer-consumer model is that in our case all the logs are considered equal and it is not required for Sam to bring the logs to the construction site in the same order as Jack collected them in the forest.

Tasks are very important both for competitors (students) and task developers (teachers): students have been "pushed" to think on computer science, educators should think about harmonization of syllabus of computer science. Creative, interesting tasks are the main drive for the Bebras contests.

3 Research in Connection with Bebras Activities

The annual Bebras challenge provides a lot of data for making inquiries on how students accept informatics concepts, how they develop computational and algorithmic thinking, what types of tasks help attract and motivate them for further involvement, etc. Some countries started to develop research papers year by year. Other countries have published overviews of tasks with detailed explanations on

Figure 10: Research papers collected at the website `https://bebras.org`

how to solve the tasks and what concepts are behind them. There are articles to promote the Bebras challenge in particular countries, and also articles dealing with particular contest results; Figure 9. The Bebras community collects articles and publishes their list on the Bebras website annually;[1] see Figure 10.

4 Conclusion

Finding the right balance between continuity and innovation is crucial in informatics education. While continuity may seem monotonous, it provides a sense of stability and comfort in our daily lives. Similarly, in teaching informatics, maintaining a consistent framework of lessons, problem-solving exercises, and core concepts can create a comfortable learning environment. Additionally, occasional contests can serve as motivating factors for students.

However, the most significant aspect of introducing informatics in schools is the human connection. Amidst long hours at work and moments of uncertainty, receiving messages from others who share the same interests and struggles can be

[1] https://www.bebras.org/publications.html

incredibly impactful. It is essential to foster a culture of dreaming, searching, and communication, both in everyday life and within informatics education.

To engage students and recognize informatics as a scientific discipline, we should strive for a more successful involvement. Well-organized activities with intriguing and exciting tasks can immerse students in the world of informatics, helping them grasp the core concepts and develop a genuine interest.

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