Algorithms Unplugged: a Card Game of the Bebras-like Tasks for High Schools Students

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Abstract. The way to ensure that students will learn informatics (computer science) concepts is focused on learner’s intrinsical motivation. Informatics concepts based on tasks and puzzles raise students' interest. Teachers need diverse activities that can lead students to deeper understanding. Algorithms are very important part of informatics. Thus we need to introduce various algorithms even at school. Based on our long experience at informatics education research, we proposed an algorithm card game in particular for high school students to discover Algorithms Unplugged. For this purpose, Bebras-like tasks were created, by placing one task per card. An idea of the card game was originated on the ground of the Bebras tasks from the International Challenge on Informatics and Computational Thinking. The Algorithms Unplugged are closely linked to CS Unplugged activities.

Keywords: Algorithms Unplugged, Bebras-like tasks, computational thinking, informatics education, informatics concepts, problem solving.

1 Introduction

Many countries are now moving to increase the amount of informatics taught at high school level. This is partly driven by the dramatic shortage of computer science graduates in western countries. Also a broader view of computer science beyond just programming attracts those who are interested in the bigger picture, rather than programming as an end in itself.

Focus on key concepts in informatics improve students' problem-solving skills, students become stronger critical thinkers and problem solvers [1], [2]. Thus we have analyzed the informatics key concepts and have searched for learning methods to convey the concepts. For example, binary representation has some obvious conversion skills that can be learned, but the key concepts are things such as the exponential increase in descriptive power with each bit added. Algorithms are often published as a shopping list of many different algorithms, whereas the key concepts are more about how different algorithms can have a nonlinear difference in performance, and that some problems are intractable.

1 http://www.bebras.org
2 http://csunplugged.org
Many of the technological innovations of recent decades have relied on algorithmic ideas and computational thinking. Algorithms not only enable to develop better programming skills, but they are the key to several recent scientific discoveries. Only because of clever algorithms used by search engines can we find desirable information in the World-Wide Web.

Algorithms describe the way how computers process information and how they execute tasks. The problems solved by algorithms have big variety, for example: How to find an exit from inside a labyrinth? How to plan a tour visiting several towns in the cheapest possible order? How to share information and keep secrets as well? Solving these challenging problems requires logical reasoning, computational imagination, and creativity, of course. The developed tasks can be understood without any particular previous knowledge about algorithms and computing.

Students learn better when they are given the opportunity to construct knowledge themselves through experience. Another key tool in supporting students’ construction of mental models of these concepts is the use of analogies and metaphors for the chosen of algorithms [3].

The use of games to promote student’s learning has been done in the past to capture student’s interest as all of us learn better when we are motivated [4]. Student motivation can be described as a student’s willingness, need, desire and compulsion to participate and be successful in the learning process [5]. Some researchers have considered the relationship between student motivation and impressions of computing subjects. Students who feel they have a strong motivation for studying a subject have a more positive perception of the subject and about the amount of practical work involved, the clarity of the subject matter and their final grades [6].

2 Algorithms Unplugged and CS Unplugged

Computer scientists emphasize problem solving in the field of informatics. A collection of learning activities called Computer Science Unplugged was developed by Tim Bell and his colleagues. These activities expose students to main concepts in informatics through engaging games and puzzles without requiring a computer. The CS Unplugged activities have become more and more popular among educators in different countries.

The CS Unplugged contains activities on various topics in informatics, such as how computers store information (the binary system and the representation of pictures as pixels), and algorithms (searching and sorting). Other interesting topics include cryptography and networks. The CS Unplugged activities demonstrate these topics using games, magic tricks, and other entertaining methods that require only the simplest equipment, primarily worksheets [7], [8]. Main goal of the CS Unplugged is to change students’ views of the nature of informatics, so that students will have a rough idea of what informatics is. Especially important is the students understand that fundamental concepts of informatics do not focus on the computer, and that informatics is more than programming.
Also, it is important to show students that informatics requires a mathematical way of thinking and supports a computational thinking.

The *CS Unplugged* focuses on a few algorithms (e.g. sorting and searching) and presents detailed activities. However main attention is paid to various attractive informatics problems (networks, cryptography, information theory, finite automata, etc.).

Using idea of the *Algorithms Unplugged* we would like to focus only on various algorithms and help students to understand their main concepts by solving small problem based tasks.

3 Method

Students usually like problem based tasks solving activities. The *Algorithms Unplugged* cards are for informatics study. There are various studying methods. For example, students can discuss the discovered algorithms in pairs or present the learned algorithms practically by playing or using other visual tools. The card games based on Bebras-like tasks should stimulate teachers and students to deepen their knowledge in algorithms and also inspire cooperation and work together, including collaboration in decision-making, looking for the best solutions, etc. [9].

4 Examples

A set of Bebras-like cards (aimed to students age 15 to 19) is developed. Four cards are shown below. They present the following algorithms: the sieve of Eratosthenes; quick-sort algorithm; the traveling salesman problem; and binary search.

5 Future works

Informatics education should be taken seriously and combine various forces. To obtain deep understanding of algorithms, formal lessons are not enough attractive for keeping students' motivation. Attracting students to get fundamentals of algorithms is a challenge for teachers [10]. An idea to bring algorithms through developed tasks and card game is proposed. An aim is to present various algorithms in an understandable way using attractive formats and develop students' computational thinking. Algorithms are introduced by using various storytelling questions. Teachers are asked to participate in creating and testing tasks.

However, a future goal is to examine the effect of *Algorithms Unplugged* activities on different age of students' cognitive load as well as their ideas on what informatics is about.

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Fig. 1. Examples of *Algorithms Unplugged* cards
References