Work in Progress - Initiating the Beaver Contest on Computer Science and Computer Fluency in Israel

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Abstract - **Attracting students to computer science studies has always been a challenge. Contests play an important role as a source of inspiration and can increase students' interest in the contest's related domain. The Beaver international contest on computer science and computer fluency was established with the goal of conveying computer science concepts to as many youngsters as possible and of motivating them to become more interested in computing. For the last few years the contest has been operating in several countries in Europe (http://www.bebras.org). Recently, in order to attract youngsters to study computer science, it was planned to initiate the Beaver project in Israel, while adapting its framework to the requirements of the national educational system.**

Index Terms - Computing, Computer fluency, Contest.

THE BEAVER INTERNATIONAL PROGRAM

Most competitions related to computers and information technology are intended for very talented students and focus on narrow areas such as developing algorithms and programming. The International Beaver program [2] addresses this by having students solve problems from a broad range of areas without using programming [3,5,6]. The idea of developing competitions based on informatics and computer fluency for a wide range of students started in Lithuania at the end of 2003. It was named "Bebras" ("Beaver" in English) after the hard-working, persistent, intelligent, and lively animal.

Goals and Underlying Model: The traditional style of teaching/learning in school is usually designed so that students can acquire explicit knowledge based on a thorough understanding of the topic learned. However, this approach alone might fail to educate students to become self-learners who can navigate in the rapidly growing world of knowledge [1]. The activities of the Beaver program are based on informal learning-by-doing while solving attractive and challenging tasks; no preliminary formal knowledge of computer science is required. The main goals of the Beaver program are to promote students' interest in Computer Science (CS) and Information and Communication Technology (ICT) from the very beginning of their school career, to motivate students to learn and master computers, and to engage them in computational thinking [3,4,8]. The contest is intended for all lower and upper secondary school pupils, who are divided into four age groups (Cadets (age 11-12), Benjamin (age 13-14), Junior (age 15-16), and Senior (upper secondary school level)). Students have to solve 18 to 27 tasks at different levels within 45-60 minutes; they record their answers on the computer. These tasks do not require prior knowledge of the topics, but do require students to be able to reason with common structures within the CS/informatics canon [7].

More than 10 countries now participate in the Beaver program [2] and recently Israel joined the program. Since the contest is international, one specific challenge is to balance between national and global standards. Hence, discussions on common standards and tasks suitable for all countries take place at annual international workshops. A shared collection of tasks has been developed including mandatory tasks to be included by all countries in their contests; to this, additional tasks can be added to adapt the competition to the educational framework of each country. The contest's organizers, from different countries, have reported that according to surveys and informal feedback, the contest motivates students to get to become better acquainted with computing and information technology.

CHALLENGES: DEVELOPMENT OF ATTRACTIVE TASKS

One main underlying principle of the Beaver contest is to introduce, in a student-motivated and attractive way, a variety of core and even advanced CS concepts in a short time. The key idea was to introduce to students interesting problems that do not require specific pre-knowledge in a way that leads to explorative learning regarding how to deal with problem-solving tasks, as well as to informally familiarize them to core concepts and principles of the domain. This approach was adopted by the Beaver Israeli team regarding the development of tasks for the Israeli students.

Each problem presented to competitors should be attractive, inventive, as well as incorporate tricks and surprises. The problems have to be carefully selected, taking into account different aspects of each problem, i.e., what educational feature it contains and how to evaluate its attractiveness to students (whether it stimulates the motivation of learning) [3,5]. Criteria for good tasks have been developed [5]. Using a proper "narrative cover story" problem statement enables many aspects of CS and ICT to be underlying topics of a Beaver task [3,5].

The tasks involve concepts such as algorithms; data structures (heaps, stacks and queues, trees, and graphs);

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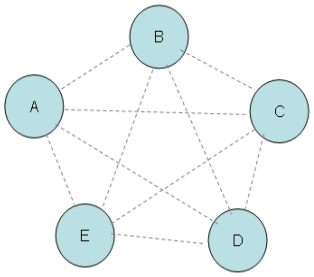
modeling of states, control flow and data flow; human-computer interaction; graphics, etc.

***Task Types*:** The tasks are classified according to the following criteria that illustrate types of problems and computing topics chosen by experts as appropriate for the Beaver contest:

- **(INF) Information comprehension:** Representation (symbolic, numerical, and visual)**,** coding, and encryption.
- **(ALG) Algorithmic thinking:** including programming aspects**.**
- **(USE) Using computer systems:** Search engines, email, spread sheets; general principles, but no specific systems**.**
- **(STRUC) Structures, patterns and arrangements:** Combinatorics**,** discrete structures (graphs, etc.)
- **(PUZ) Puzzles:** Logical puzzles, games (mastermind, minesweeper, etc.)
- **(SOC) ICT and Society: S**ocial, ethical, cultural, international, and legal issues**.**

Example (Benjamin, level medium, STRUC): *There are five towns in Beavers' State: A, B, C, D, and E. The government intends to build railroads but there is not enough money to connect all the towns. Therefore, the following was decided: the towns should be connected by as few roads as possible to ensure that each town will be reachable by changing a train not more than once. Mark these roads on the draft.*



Click the towns that you think should be connected by a railroad. If you click towns that are already connected, then the railroad between them will vanish.

PILOT IMPLEMENTATION IN ISRAEL

Computer science for high school is learned in Israel as a selective subject. Recently a new elective CS program for middle school has been developed and its pilot program has been implemented. Since students are not obliged to study computer science and there is an attractive set of other scientific/technological subjects that students can choose to major in, it is important to find unique ways to attract students to computer science. The above considerations motivated us to check the possibility of extending the Beaver program in Israel to middle school students and lower high-school class students who have not yet begun learning computer science. Our main goal was to disseminate seeds of computational thinking, and to prompt students' curiosity and positive attitudes towards computing. Specifically, we aimed at promoting fundamental understanding of computing, developing students' problem-solving abilities, and promote fluent use of ICT. Moreover, we hoped that extra-curricular experimental learning, typical of Beaver which encourages competition, will have a positive impact on the learning culture at schools. We developed a flexible implementation model based on: (a) an initial contest which does not require previous knowledge or training, (b) a high-level final contest, and (c) in-between attractive experimental preparation so that the initial spark can develop into a more sustained interest in the final contest as well as in further CS studies. Teachers constitute the cornerstone of the program and mediate among the program developers, managers, and students. One main challenge was to convince teachers to take part in the pilot implementation and to supply them with appropriate tools to adapt the program to their school educational milieu. The teachers encouraged students join the program and dealt with pedagogical and management aspects to ensure its successful implementation.

The program has been successfully conducted for the last few months in the Davidson Institute of Science Education at the Weizmann Institute of Science in Israel. It arose from a partnership among academia, the Ministry of Education, and K–12 educators. The program is supported by a site developed in the Moodle environment. Eight hundred students (Benjamin and Junior) from 20 schools around the country have participated so far in the program's activities; of these, 470 students (170 Benjamin, 300 Junior) have participated in an initial contest. A final and more challenging contest is planned for June 2011.

An informal preliminary study was conducted, which revealed that the students were enthusiastic about solving challenging tasks and the idea of competing. Next year we plan to expand the program and to accompany its implementation with a thorough formative study related to various pedagogical and management aspects.

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