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SUPPORTING THE BULGARIAN YOUNG TALENT IN THE FIELD OF INFORMATICS

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Dedicated to Edward Friedman
on the occasion of his 80th anniversary

Abstract. In this paper I share some impressions from my short communication with an exceptional person—Professor Edward Friedman from Stevens University of Technology, USA. Working in the field of integrating ICT in education in the early 1990s, he launched several joint projects with Bulgarian educators. The essentials of these activities were real projects in the school. This idea was recently implemented at the university level as well in the context of IT. I discuss this matter in the final sections of the paper.

1. Introduction—the roots of informatics in a Bulgarian educational setting. In 1979 the Bulgarian Academy of Sciences and the Ministry of Education formed a *Research Group for Education* (RGE) and charged it with the development of a new curriculum which would incorporate computers as its natural component [18].

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Fig. 1. The first Bulgarian Logo textbook for 5th grade (1984, R. Nikolov)

Fig. 2. Language and Mathematics for 6th grade (1985, R. Nikolov, E. Sendova)

Fig. 3. In the computer lab of School 119, Sofia (one of the RGE schools)

The experiment involved 29 pilot schools, which constitute 2% of the Bulgarian K-12 schools. The main principles of RGE were *learning by doing, guided discovery, and integrated school subjects.* The educational materials designed expressly for the experimental schools included textbooks, teacher guide-books and the *Mathematics and Informatics* bulletin for teachers. Lego-Logo-based computer environments were developed and tuned to specific subject domains and oriented to the students' exploratory activities (Fig. 1–4) [14, 15]. The RGE concept allowed students to move from constructing controllable models to fully programmable microworlds and in this way to participate in building their knowledge [19].

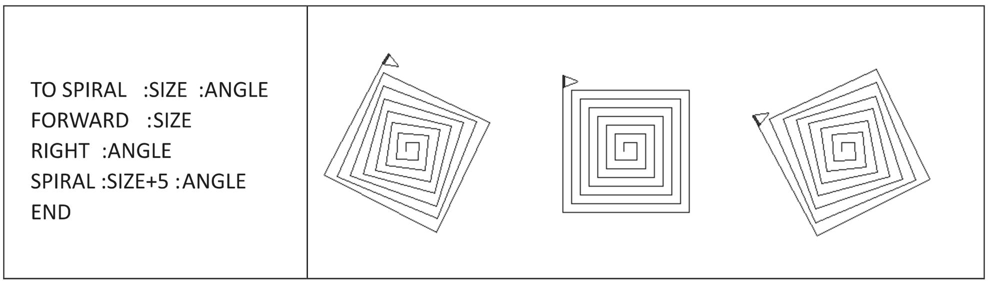

Fig. 4. Recursive procedures with parameters, a lesson for the 5th grade [19]

Geomland, an environment supporting mathematics explorations in Euclidean geometry (Fig. 5), was developed by a team of the Faculty of Mathematics and Informatics at Sofia University, supervised by Bozhidar Sendov [17]. *Geomland* could be seen as a *mathematical laboratory* allowing students to construct and investigate the properties of geometrical objects, to formulate hypotheses and to construct proofs. This is a successful teaching strategy for inquiry-based learning of mathematics and science, applied further in a larger Bulgarian context [4, 5, 13, 16].

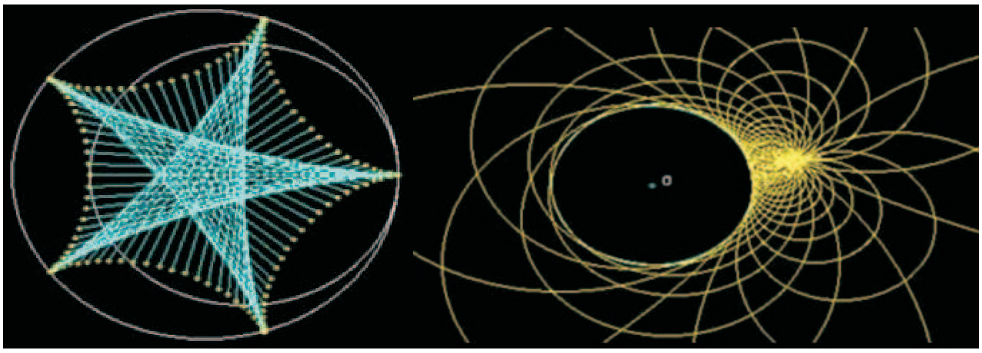

Fig. 5. Explorations with Geomland,
`http://sunsite.univie.ac.at/elica/PGS/INDEX.HTM`

The RGE experimental results influenced the compulsory education in informatics in Bulgarian school practice, introduced for the first time in the year 1986 as a separate subject, Informatics (Fig. 6). Bulgaria was among the first countries to have done it.

Fig. 6. The first Bulgarian textbooks for the compulsory subject, Informatics (1986, P. Barnev, P. Azalov; A. Angelov, K. Garov, O. Gavrailov)

A well-developed network existed in the early 1980s involving schools, public units for extracurricular activities, universities and scientific organizations. It enabled students with high interest in informatics to get involved in an appropriate community to satisfy and develop their intellectual needs. The Specialized team for extracurricular activities established at the Institute of Mathematics and Informatics and guided by Petar Kenderov, played a key role in educating the most advanced pupils and their teachers. That was a time when many enthusiastic people – students, teachers, scientists and parents, contributed to a successful start in the new field of educational informatics.

The *High School Students Institute of Mathematics and Informatics* (HSSI) was established in the year 2000 as a response to UNESCO's decision to celebrate the World Year of Mathematics. The founders of HSSI were the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences (IMI—BAS), the Union of Bulgarian Mathematicians, the St. Cyril and St. Methodius International Foundation, and the Evrika Foundation [7, 11, 12]. Every year about a hundred of high school students between the 8th and 12th grades (aged 15 to 18) get involved in HSSI. The participants in HSSI choose a problem on mathematics, informatics or information technologies and work individually or in a team, supervised by a teacher or another specialist. The results are reviewed and the best works are accepted for presentation at two conferences and further developed at a summer school specially designed for the HSSI students. This form provides appropriate options for students even from small towns to participate in research activities and to develop their intellectual potential.

In 2001 the HSSI was invited to select Bulgarian representatives for the *Research Science Institute* (RSI). This is a six-week educational summer program held at the Massachusetts Institute of Technology (MIT), USA. The RSI brings together high-school students from different countries having a keen interest and ability in science and mathematics. This is a sign of recognition of the Bulgarian achievements in mathematics and informatics on the international stage [12].

The first competitions in programming in Bulgaria appeared in the late 1970s, thanks to the well-developed network for teaching advanced students in mathematics and informatics. Regular national competitions in programming have been conducted since 1981. In the beginning the participants presented their results on paper. Later, when microcomputers became widespread in schools, competitions switched to an electronic medium.

The *First National Olympiad in Informatics* was held in May 1985. An international *Open Competition on Programming* (Sofia, May 17–19, 1987) was organised within the International Conference *Children in the Information Age*.

Because of the great interest, six months later, at the 24th session of the General Conference of UNESCO in Paris, Blagovest Sendov, a member of the Bulgarian delegation, proposed an International Olympiad in Informatics (IOI) to be included in the UNESCO Plan [10]. The proposal was approved and Bulgaria was authorized to organize the first IOI. It was held in Pravetz, Bulgaria, from 16 to 19 May 1989. There were 46 contestants from 13 countries [8, 10].

In 1982 the first competition in *Mathematical Linguistics* was organised in a format similar to the mathematical competitions. The organisers were the Union of Bulgarian Mathematicians and the Ministry of Education. The success of these contests in Bulgaria and other countries led to the birth of the idea of the International Olympiad in Linguistics, which was held for the first time in September 2003 in Borovetz, Bulgaria [6].

During the whole history of Olympiads and competitions Bulgarian pupils have successfully participated in various contests in *Mathematics, Informatics* and *Theoretical, Mathematical and Applied Linguistics.* This is an outstanding way to involve young people in extending their competences required for the knowledge-based society. In view of the number of the medals our students have been awarded in the international Olympiads [8], we are proud of the fact that Bulgaria outruns countries with much better economies. These young people are our national capital.

Table 1. Number of medals in IOI of the top 6 countries [8]

Country	Gold	Silver	Bronze	Total
China	75	24	12	111
Russia	55	33	12	100
Poland	36	37	28	101
Bulgaria	24	41	31	96
USA	45	34	15	94
Iran	21	49	22	92

The Bulgarian achievements in the field of school informatics and mathematics were noticed by Prof. Edward Friedman, and he spent several months (in 1992) in Bulgaria, at the Institute of Mathematics and Informatics, Bulgarian Academy of Science (BAS), as a Fulbright Scholar. A year later I was invited to take an interview with him for a Bulgarian newspaper oriented to teachers' needs – *Uchitelsko delo.*

2. Interview with Edward Friedman. I started my interview [3] with a question about his Einstein award and Prof. Friedman underlined that this was just one of 14 awards named "The Pride of New Jersey" and told me about the contributions of other persons having received such awards (obviously, not because there was nothing to say about himself)... Next he shared his belief that education was a growing value and the greatest enemies of this positive development were the wars that broke out in different parts of the world.


Учителско дело 5 Сряда, 8. IX. 1993 г. Брой 27 (3070)

Професор Едуард Фридман, носител на наградата "Айнщайн" за 1992 г., пред вестник "Учителско дело"

България има силна образователна система и много талантливи хора

Интервюто води Петя АСЕНОВА

Fig. 7. The interview with Edward Friedman in *Uchitelsko delo* [3]

From our conversation I learned that his passion for Physics had come in the early 1950s when many talented young people in the US were attracted to this science, in the hope to change humanity for better. This choice was also influenced by his physics teacher from the high school. At MIT he met remarkable scientists and teachers who lit even more sparks for physics. There he formed the philosophical belief that to understand the world better, we need to know physics better. As a student at MIT, Edward Friedman was actively opposing the attacks on Oppenheimer—his hero among the American physicists [3].

To my question about his impressions from the Bulgarian education, Dr. Friedman shared his appreciation of some good Bulgarian school practices, such as exploring geometric transformations in a specialised computer environment, which could be adapted for the American education. "Bulgarian experience here is great. There is a well-designed and experimentally verified software that supports these topics in an excellent way" said Prof. Friedman. He also recommended Bulgarian textbooks in Mathematics to be translated for American schools. During his stay in Bulgaria he marked the beginning of other joint projects in the field of mathematical education and the integration of information technology, which became reality later [3].

In his concluding words Prof. Friedman said: *The greatest wealth of every nation is the capabilities of its citizens. There are many talented people in Bul-*

garia in the fields of mathematics, informatics, natural sciences and engineering. These, combined with the intelligence and sense of humor of the Bulgarians, are the basis of its viability.

Taking this interview I was deeply impressed by the personality of Edward Friedman, by his true friendship towards Bulgaria. Twenty-three years later his words still inspire optimism and courage.

In 1995, in the frames of the international research project COMPED (Computers in Education), I went to Washington, DC, to report the results about Bulgaria. There I met another American professor. The time has erased his name from my memory, but I still remember his reaction after he learnt that I knew Edward Friedman. The professor (usually restrained) smiled and said lively "You know Ed!". And until the end of the symposium I had the feeling of a new friend with a warm attitude towards our country. The key words were "Ed Friedman".

3. Real-Time Investigations. In the fall of 1994 several Bulgarian schools, coordinated by Evgenia Sendova [19], joined an initiative of the Center for Improved Engineering and Science Education (CIESE) for carrying out real-life scientific experiments in their local environment. The topics of the projects included acid rain, water quality, etc. The students' work required gathering real data, analyzing it, making conclusions and proposing decisions. The students did it in a team, communicated with each other and synchronized their activities. They used the Internet for communication, gathering data, comparing their results with similar explorations. According to the teachers and researchers participating in the whole process, the students increased their interest and motivation to learn such topics in a real environment. The teachers' role in the projects was to advise students rather than to deliver new matter. Working on the projects the students began sharing the results with their peers from other countries and became a part of a large international community [19].

Edward Friedman was the driving force behind the implementation of those projects in an international setting. Later this experience was disseminated in other Bulgarian schools.

4. Near-real projects at university. As Associate Professor of the Computer Science Department at the New Bulgarian University, I have participated for more than 15 years in preparing future software engineers. I understand more and more the importance of what Professor Friedman did for the Bulgarian schools in those days, with his contribution to the learning process through real investigations.

Such an approach has many advantages for the future IT specialists:

- Having experience with real projects, students become more confident and motivated for their future career and the transition from university to the career becomes less stressful.

- The students meet situations where to solve a problem, they must obtain new knowledge—new algorithms, techniques, methodologies, technologies, libraries, programming languages, etc. Thus they obtain abilities to learn all their life.

- In addition to the technical skills, students promote their soft skills—communication, working in a team, negotiation with clients, organizational culture, etc.

- Students get an idea of the management of IT projects [1].

This approach has been reflected in the curriculum of the Computer Science Department at the New Bulgarian University since 2013. Every student at bachelor level must participate in two real projects during the third year of his/her study. These are team projects and the performance takes place in a company-like environment.

Every team has a real task, assigned by a company or by a faculty member. A supervisor is assigned to every team. In the past two years we have been adding a second year student from the MSc IT project Management to act as a team manager, with a positive effect [9].

The project selection is not a trivial problem. The task is delivered to the students via the university e-learning system Moodle. The *task description* includes the following components:

- task definition;
- technological and technical requirements;
- deliverables and requirements to them;
- timetable of the meetings (face-to-face);
- deadlines;
- presentation date;
- assessment system;
- supervisor's name [2].

After reading the tasks, students apply for individual projects on their choice. The supervisors decide to accept or reject a given applicant. So every team consists of students approved by the supervisor of the given project [1].

The organization of the performance is as follows. Each project lasts one semester (15 weeks). Students have a face-to-face meeting once per week and discuss the job they have done, as well as coming activities. The manager is responsible for the planning, deadlines, communication. There is a team leader, who is responsible for the technical performance—sprints and some architect functions. The job is divided according to the competences of the team members. One is responsible for algorithms, others are coders, testers, writers of documentation. Students use collaborative communication tools—usually Github. The supervisor stays behind—giving advice and directing the working process if needed; sometimes he/she plays the role of a customer. The project finishes with a public presentation (Fig. 8). Every student presents the part he/she is responsible for in the context of the whole project. Students from the same team can have different marks—this depends on their progress and presentation [1].

a) Consultations in Haemimont Games company

b) Public defense

Fig. 8. Learning with real projects, NBU BSc Programs, Computer Science Department, 2013

5. Conclusion. Learning trough real projects takes place in curricula from elementary school till higher and adult education. Edward Friedman spent some time in our country in the early 1990s to share his experience with Bulgarian educators in the field of mathematics and informatics. His strategies were applied mainly in the field of mathematics education but were influential in the informatics context as well. The importance of such strategies is that students get to understand more what mathematics and science are, where they are around us. Furthermore, students become constructors of their own knowledge and more motivated learners.

We have implemented learning through real projects as a compulsory curriculum element for future software engineers at university level. Apart from the above mentioned advantages, the real or near-real experience give students confidence and readiness for starting their professional carrier. Collaboration with IT companies is a promising direction for cooperation between universities and business.

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