Embracing and enhancing ideas as a strategy for ICT education

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Abstract: The paper deals with effective ways of overcoming the most typical challenges the ICT teachers are confronted with. Based on their experience the authors claim that appropriately designed methodology, textbooks and computer environments could stimulate the learners (teachers and students alike) to embrace and enhance ideas so as to better express themselves.

Keywords: active learning methods; project-based learning; ICT-enhanced skills; creativity

1. The problems of teaching ICT at school

In times when the technologies are changing very dynamically the most important issues in the context of the ICT education are *how* and *when* to apply them. Maybe even more important are the questions of *whether* and *why to use ICT* in a specific situation. In reality, the technologies are often treated as an object of study rather than as means enriching the educational process. Therefore, it is only natural that the teachers are not very motivated in using them - on one hand, many are still not familiar enough with ICT, and even if they are, it is difficult for them to catch up with their rapid development; on the other, the effective integration of ICT in a class setting requires that the learners are in the centre and learn by doing/making. Our experience shows though that most of the teachers are lacking experience in this direction. In order to teach in such a learner-oriented manner the very teachers should be educated how to express themselves by means of ICT. That is why, in our courses we help teachers to understand that it is important for their students not only to master the ICT skills of *today*, but also to get ready for solving complex problems of *tomorrow*.

2. The specifics of our approach

Our approach is based on a specific *I*Teach* (*Innovative teacher*) methodology in which the notion of *ICT-enhanced skills* has been defined as a synergy between technical and *soft* skills – transferable skills in the Life Long Learning society. Putting the emphasis on the development of such skills in the context of ICT education has been addressed in the frames of Leonardo da Vinci *I*Teach project* [1]. The *I*Teach* methodology [2] has been proposed based on active learning methods – the student is in the centre of the learning process, the teacher is a guide and a partner in a project work based on didactic scenarios encouraging the creative thinking of students.

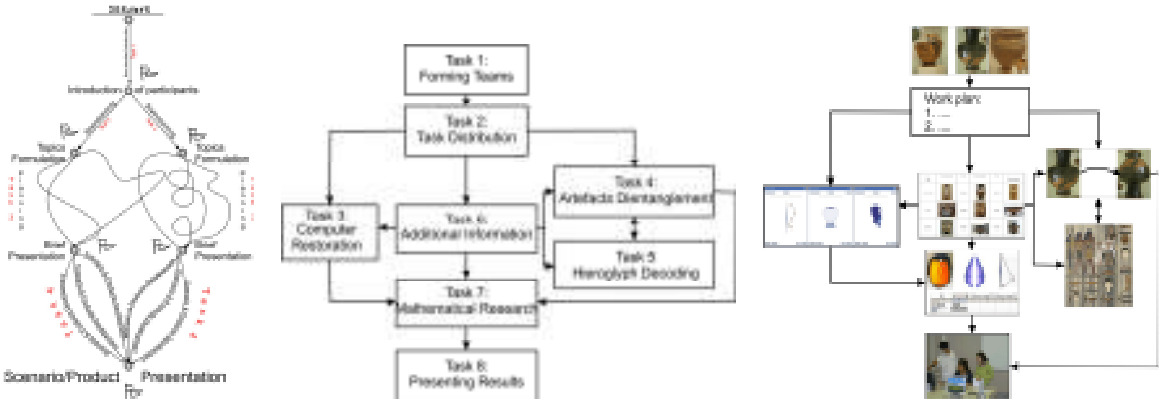
We shall illustrate first how the *I*Teach* methodology has been implemented in a set of ICT textbooks and teacher's handbooks for the junior high-school so as to allow teachers and students to enhance the underlying ideas in their field of interest.

Typical for the structure of textbooks [3] is that there is a common thread linking: the tasks in a lesson; the lessons in a common ICT theme; the ICT themes in the whole textbook. An important feature of the lessons' structure is that they start with a *challenge* – a creative problem motivating the introduction of new knowledge and skills. The final book of the series is developed as a challenge itself with the theme of coding, which passes as a *red thread* through the whole content. Each lesson deals with ideas and tools for solving problems considered as milestones towards a final goal (Fig. 1a). The *grand finale* is a project (*Decoding the past*) requiring the students to put together all the subject knowledge and skills acquired during the school year and to work creatively in teams and present their results (Fig.1b). For the purpose they are expected to decode a message and to create computer models of ancient Greek vessels so as to restore them, figure out their function (Fig.1c) and thus - to help a local museum.

Let us note that the soft skills expected to be developed when working on this project include *team work* (planning, task distribution, communication skills, conflict resolving), *information skills* (looking for and selecting relevant information, critical thinking), *presentation skills* (selecting the most appropriate tools for a specific task, written and oral presentation of the milestones and the final product). Furthermore, the project output is expected to be "put on the table", i.e. to have a finalized appearance and to be sharable with others.

The textbooks, as a whole, and the *Decoding the past* project, in particular, are designed so as to foster the creativity of both teachers and students. In the case of the teachers, they are encouraged (in the handbooks and

the training courses) to develop variations of the project theme taking into account their own expertise and students' interests. As for the students, their creativity is stimulated by offering them a freedom of choice: 1) of a path towards a specific milestone; 2) of a tool representing their ideas and 3) of a manner of presentation of the results. The two aspects of the project work, viz. generation of creative ideas and their implementation in a sharable product, lead to the *innovativeness* – an important characteristic of the creativity based society.



(a) (b) (c)

Fig. 1 From an abstract *I*Teach* Scenario to a specific *Grand finale*!

Our experience in applying the *I*Teach* methodology shows that it is most effective when combined with computer environments (DALEST-Elica applications in this case [4]) designed to enhance the learner's spatial imagination ([5], [6]). In the next section we are presenting some examples of the effects of the integration of the methodology, the educational materials and the computer applications under discussion when working with teachers during a set of training courses held at the Faculty of Mathematics and Informatics, Sofia University. A case study of the creativity of an 11-year old student manifested in the context of the coding-decoding project is discussed as well.

3. Embracing and Extending the Ideas

3.1 By teachers

The *I*Teach* methodology has been implemented in a series of teacher training courses ([7], [8], [9]). We would typically start with identifying the expertise and the interests of the participants by inviting them for a 3-minute introduction of themselves during which they had to answer 3 questions: *In what do you consider yourself an expert? How did you acquire this knowledge? How do you know that you are an expert*? Then the challenge for them was to design a scenario for a project which would be a variation of *Decoding the past* in chosen by them context. Thus the work with the teachers was an interplay of ideas: starting with what we hoped to be an attractive topic (reconstructing an ancient object by decoding and creating a computer model of it), then designing and developing individual projects tuned according to their interests and expertise, further on – creating a catalogue of project ideas to be shared by the learning community. This model of a learning process was something they could in turn apply in their own classes.

We discuss several project ideas inspired by the *grand-finale project* and then implemented by in-service teachers within training courses for ICT education held at the University of Sofia (in the Spring of 2008).

Some of the teachers embraced the idea about modelling of a broken rotational object and modified it for other objects, *Tsar Bell* being an impressive example suggested by the in-service teacher Tania Monova (Fig.2a and Fig. 2b).

Fig. 2a The enormous Tsar Bell

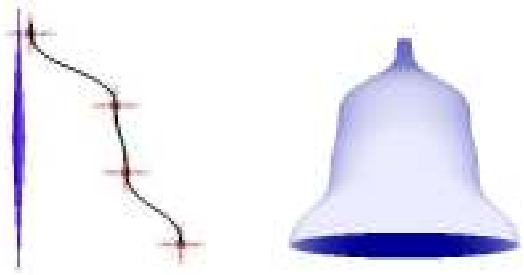


Fig 2b A computer model of Tsar Bell with Elica applications

The original project idea was further enhanced by the teachers who showed a great creativity when integrating several computer applications to express better themselves. A teacher in specialised school for fashion design developed a project for hat models (Fig. 3a); other teachers designed a collection of computer models of modern jewellery (Fig.3b) and light sources (Fig.4).

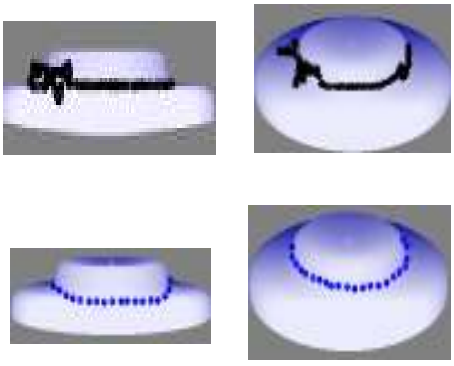


Fig. 3a Modelling of hats (*Bobi Atanasova*)

Fig. 3b Integrating outputs of two Logo environments (*Diana Tsvetkova*)

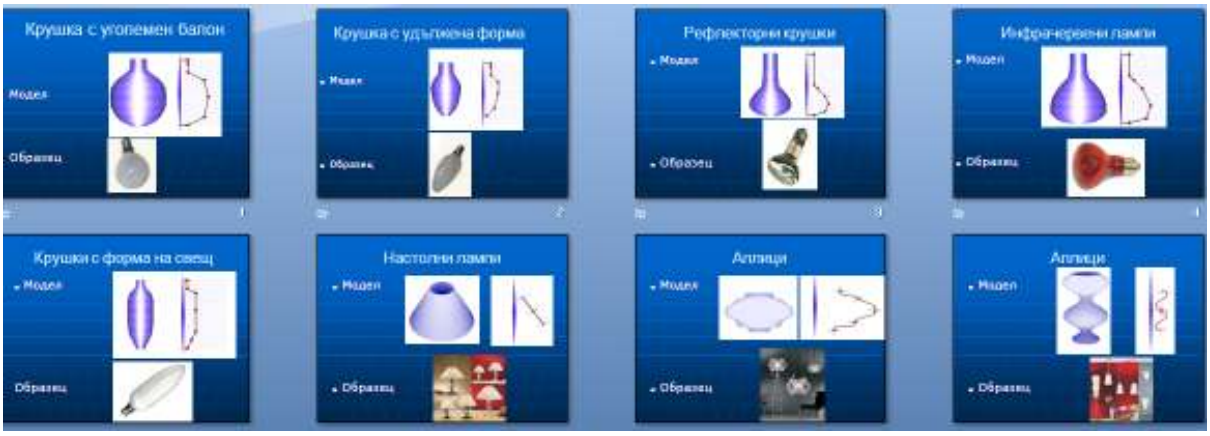


Fig. 4 Modelling of light sources (*Marian Radulov*)

The interesting phenomenon was that these authors of projects were genuinely surprised by the final results since their initial ICT skills were rather modest. Here is a typical feedback at the end of the course:

- *It is amazing that for such a short time I learned so much! I entered a world in which I can improvise and give play to my fancy without limits...*

Another interesting example was the way a teacher had extended the project about a coding based on substituting letters by special symbols (Fig.5). She enhanced the ideas from the textbook by interweaving them in fantasy stories, related to students' life – love secret messages, lexicons; horoscopes, etc. In the style of *One Thousand and One Nights* each story (build on the set of tasks) started in a lesson and continued in the next one, the students being the main characters! Furthermore, each story was just an act in a bigger scenario. Thus, passing from challenge to challenge, the students were expected to develop not only specific technical skills but also such an important soft skill as the ability to communicate with each other.

Fig. 5 The coding (letter-substitution-by-special-symbols) as a red thread in a teacher didactic scenario (*Valiya Ivanova*)

As a whole, our experience in these teacher training courses confirmed our belief that learning occurs best when learners enjoy the process; when it creates appetite for more learning and stimulates their wish to share ideas and findings with others.

Here are some thoughts of the teachers who tried out the *I*Teach* methodology immediately after the courses:

- *The work was driven by the interests of my students and they were ready to face challenges*
- *Even though I was prepared for an enthusiastic work, what happened really surpassed my expectations.*

Our expectations when working with students have often been surpassed as well. Here follows an example.

3.2 By pupils – a case study

Next we describe a case study of a 5th grader who found a prototype of a textbook cover featuring a code used in the textbook. This code is a clock modification of the so *called spoken tic-tac-toe code* used by prisoners in various populations [10]. The letter substitutions in this code are derived from the geometry of the tic-tac-to grid inside the grid lines. To make the system work, the sender of the message starts by declaring a start time; if it is, say, 11 o'clock, the first letter of the alphabet, **а**, will be placed in the top left position, and the rest of the letters will follow their normal sequence in a clockwise manner, the ones not fitting, being placed around the central cell. Thus the symmetrical words **ТИ** and **ИТ** (respectively, *You* and *IT* in Bulgarian) have codes which are also symmetrical (Fig. 6):

This case study was entirely improvised –the student did all activities by herself, without any supervision.

Fig. 6 Textbook cover prototype with the tic-tac-toe code for the Bulgarian alphabet

When the girl found the prototype of the cover, she noticed the strange signs on it and asked about their meaning. After a short explanation about the tic-tac-to code she withdrew for a dozen of minutes and came back with a task – a sheet of paper with coded text on it (Fig. 7a). Initially we were surprised that the student took silently and voluntarily the role of a teacher. She gave us a problem and expected an answer.

The most interesting situation was when we got slightly confused by the problem, because it had several subtle innovations. First of all, the text was written in a vertical strips and it took some time until we figured it out. The second surprising element was that the actual message was a recursive text. Only the first iteration was

written: *I like to tease you with a song of mine which is crafty and starts like this:* I like to tease you with a song of mine…

Fig. 7a The original task

Fig 7b The code extension

The girl's reactions demonstrated her mixed feelings – on one hand she wanted to challenge us, but on the other – to get a solution of the problem she had formulated. After we solved the problem, she presented us with a new one, then with a third one. Every time the difficulty was one level up. In one of the problems we were really confused, because whatever traversing we tested we always got some strange sequences of letters. Later on we found that these words were names of some characters of her favourite Japanese animation. During this problem solving we found that she had made her own extension of the code. She had added codes for punctuation and some special characters (Fig. 7b). We asked her why there were codes for character she did not used. The girl answered, that she had done this for completeness … in case she would need them in the future.

The new set of problems that we had to solve revealed some other interesting concepts that the student had reached by herself. One of her coded messages was coded with a mistake. When we gave up decoding, she quickly realized that there was a *typo*. She did not check all characters one by one. Instead she used some heuristic approach – codes were arranges in a circular sequence, so it was obvious, that the code of a letter near the end of the alphabet could not look like the codes of letters from the beginning.

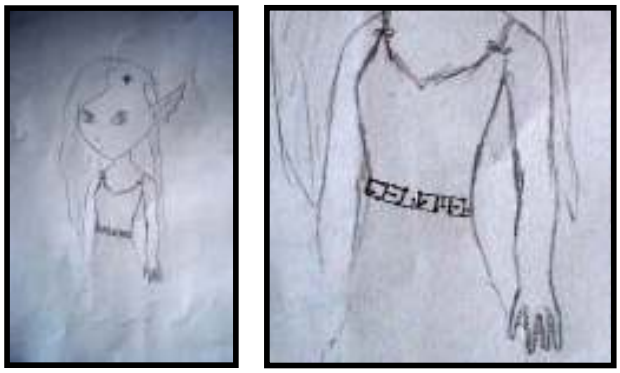


Fig. 8 The belt is inscribed "extraterrestrial"

After the initial set of problems the girl's actions literally exploded into a higher level of creativity and abstractions. Her new problems were not just problems; they were also artistic expressions of various ideas. She embedded the code in fashion drawings (Fig. 8) and made a street full of implementations of the code (Fig. 9a). All kinds of labels and company signs were coded (including the text on the trash bin).

We asked her several questions, because some usages of the code seemed weird. Surprisingly, when she used the code she actually explored various aspects (some of which we had never thought of before), like finding texts whose coded image is symmetrical or finding text where letters were rearranged in a way to show similarities between codes.

Fig. 9a A *coded* street

Fig 9b the code of a Music Club

The Fig. 9b shows an interesting achievement. The student had merged two incompatible coding systems – the one from our textbook and the coding system of musical notes. She had coded a message using our code, but transformed the appearance of the individual codes to look like musical notes on the staff. Apparently the translated script reads "Music Club" (in the Bulgarian version of the code).

The coding experience with this girl and the follow up of her exchange of secret messages with her peers confirmed to us several important issues:

- Kids love to solve problems, especially those involving mystery, challenges and unique turning points
- Kids love to create problems and to follow the solutions of their friends
- Kids can combine incompatible ideas and they do this with a sufficient level of reasoning, and finally
- Kids are imaginative, much more imaginative than we could ever imagine

Students can quickly build an ethereal world of their own, implementing ideas borrowed by our reality. They explore their worlds with the enthusiasm of a discoverer and with the consistency of a scientist.

3. Conclusions

These examples are indicative of the variety of ideas learners could generate if provided with proper stimuli - ideas which should be embraced and enhanced further by their educators.

Our experience shows that encouraging the learners to embrace a good idea, then play with it and possibly modify and extend it can provide a rich perspective for mutual enrichment among educators, teachers, and students.

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References

[1] *Innovative Teacher* project site http://i-teach.fmi.uni-sofia.bg, retrieved on 5 March 2009

[2] Stefanova E., Sendova E., v. Deepen N., Forcheri P., Dodero G., Miranowicz M., Brut M., et al: *Innovative Teacher - Methodological Handbook on ICT-enhanced skills*, Faleza-Office 2000, Sofia, 2007

[3] Sendova E., Stefanova E, Boytchev P., Nikolova N., Kovatcheva E. *IT education – challenging the limitations instead of limiting the challenges*, Proceedings of CIIT 2008, Bitola, Macedonia

[4] Elica site http://www.elica.net, retrieved on 5 March 2009

[5] DALEST project site http://www.ucy.ac.cy/dalest/, retrieved on 16 March 2009

[6] Sendova E., Chehlarova T., Boytchev P., *Words Are Silver, Mouse Clicks Are Gold?* In Proceedings of the 11th European Logo Conference EUROLOGO 2007 – 40 Years of Influence on Education (Book of Abstracts), Ed. I. Kalas, Bratislava, Slovakia, 2007, p 27, ISBN 978-80-89186-20-4

[7] Stefanova E., Sendova E., Nikolova I., Nikolova N.: *When I*Teach means I*Learn: developing and implementing an innovative methodology for building ICT-enhanced skills*, in Benzie D. and Iding M. (Eds). Joint IFIP Conference: WG3.1 Secondary Education, WG3.5 Primary Education: Informatics, Mathematics, and ICT: a 'golden triangle' IMICT 2007 Proceeding, CCIS, Northeastern University, Boston, MA, 2007

[8] Sendova E., Stefanova E., Nikolova N., Kovatcheva E. *Like a school (of fish) in water (or ICT-Enhanced Skills in Action)*, LNCS Informatics Education - Supporting Computational Thinking, pp. 99-109, July, 2008

[9] Stefanova E., Nikolova N., Kovatcheva E., Boytchev P, Sendova E, *The discovery as a part of a teaching in an IT context*, Proceeding of XXXVIII Annual conference of the Union of Bulgarian Mathematicians 2009, Borovetz, Bulgaria, p. 319-328

[10] Butler, W S., Keeney, L. D., Simon & Schuster, NY, 2000, Secret Messages, p. 161