

Challenges of teachers e-training: how to solve unsolvable problems

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Challenges of teachers e-training: how to solve unsolvable problems: This paper presents challenges and some solutions, related to the new secondary school ICT and Informatics curriculum, introduced with the educational reform in Bulgaria. The main focus are efforts to empower teachers with the new content, new technologies and methodologies for adequate their usage. The paper describes applied teachers' training framework, which was applied. This framework underlines the key role of a balanced use of eLearning to provide effective STEM teacher training, especially in the area of Information and Communication Technologies and Informatics.

Key words: e-Learning, In-service Teachers Training, Teachers' Qualification, Educational System.

INTRODUCTION

Information and communication technologies (ICT) are one of the emerging science areas that has exponential acceleration growth in the last decade. Educational reforms are quite conservative process that takes several years. Moreover, reforms implementation is slow process that constantly tries to catch up changes in the area of ICT and Informatics (Fig. 1). Thus course content needs constant renewal. The textbooks content needs to present fundamental knowledge on the one side, but on the other side they need to contain examples for contemporary application of ICT technologies and the presentation style needs to be updated as well. Textbook content and style needs to implement the changes in the students learning style. Even slower is the process of teacher training, because all teachers need to pass such training, but there is limited number of trainers that can teach ICT and Informatics courses from the new curricula. Figure 1 shows the educational process lifecycle.

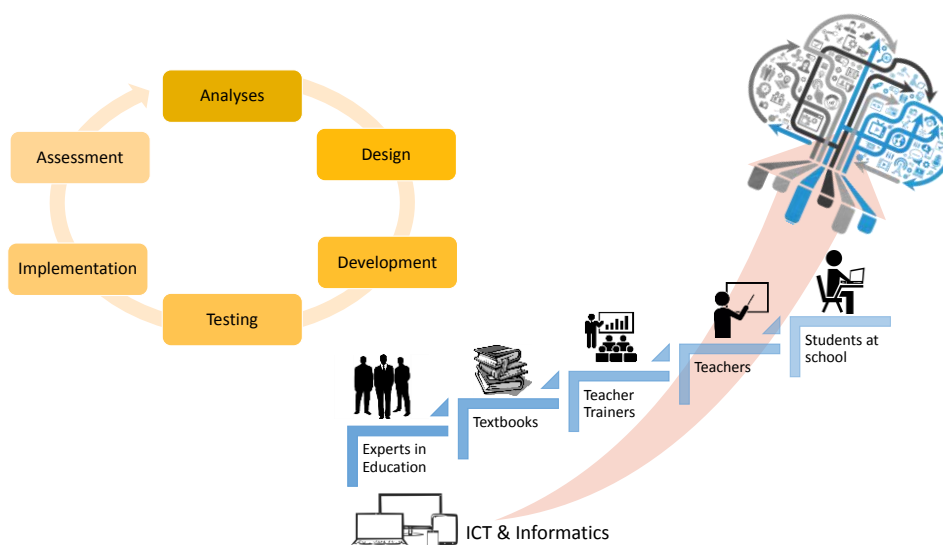


Figure 1. Educational process lifecycle

Recent years the educational system in Republic of Bulgaria was reformed. New curricula for pre-schools, primary and secondary schools were developed. Since 2016 the program is in effective use. Teaching, according the new framework, requires not only teachers to be familiar with the new course content, but also to apply new teaching methods and technologies. The main questions are: “Whether teachers are prepared for effective implementation of the educational reforms?”; “How teachers can be trained for its effective implementation?”.

Preliminary observation shows that especially for some of the subjects in area of Science, Technology, Engineering and Mathematics (STEM), the answer of this question is negative. This applies with full degree to compulsory subjects Information and Communication Technologies (ICT), Computer modeling (CM) and Informatics. Challenges, related to them, are in the focus of the paper. These subjects are in the rapidly changing area. In the same time, the majority of teachers have never been trained for the new course content – neither at the university, nor in teachers' training programs and to find qualified teacher is quite challenging. Moreover, subject like CM is never taught to students at primary school until now, and Informatics has never been taught to students at 8th grade in compulsory courses. The majorities of teachers

fills anxiety about the subject content and they are not feel confident with new technologies; they also feel lack of pedagogical skills to teach the courses in appropriate way.

The situation is like “enchanted circle” - teachers need to train students according to the new curricula, master content, which will be old at the end of the study. It seems we need to solve unsolvable problem, taking urgent actions providing appropriate teachers training and to help them to feel more comfortable and confident with the new curricula material. The question is *How?*

The paper presentation is structured as follows: Section 2 briefly overviews the related work in the area; Section 3 presents learners expectation for new teaching materials; Section 4 discusses the required teachers’ competences; Section 5 presents new possibilities for teachers’ qualifications; Section 6 describes framework for trainings, empowering teachers, and Section 7 summarizes the conclusion and sketches further work.

RELATED WORK

In many countries, it is started similar process of educational reforms and the teachers are not sufficiently prepared for it as well. Since 2014 the new computing curricula is effective in UK. A survey shows “that 54% of secondary teachers believed their students knew more about ICT and computing than they did... In addition, 74% of ICT teachers admitted to not having the right skills needed to deliver the curriculum.” [1]. Hubwieser et al [2] presents computer science (CS) education in secondary schools in several countries: Austria, Germany, Greece, Israel and Lithuania. Only in some countries, Informatics is considered as compulsory subject at secondary school. Thus only in few countries have well established university programs for teachers training. Still the majority of countries consider only Digital literacy as part of the compulsory education at secondary school. Syslo and Kwiatkowska [3] describe the changes in Polish educational system in computer science. Even with long traditions in Informatics education at school, recently the main focus was moved from learning how to program and to produce new product to usage of information technologies and already developed software applications and products. Analysis about the position and nature of computer science in school curricula were made in IFIP curriculum Task Force [4]. Bell et al [5] present computer science curricula in New Zealand schools. They implement curriculum with main objective to expose the concepts in computer science to the students and to appreciate their significance, rather than learning them in depth and details. Another issue that Bell et al [5] address are different types of implementation of computing and e-Learning in the curricula. They define three main uses of computers in education: (1) as an e-learning tool; (2) as general purpose tool (for ICT) (3) for computer programming.

NEW REGULATIONS - NEW EXPECTATIONS

New national regulations and new curricula almost for all subjects, required new textbooks and learning materials for secondary school students. In the educational process lifecycle (Fig. 1) this is the next step after the curricula design. The process of textbooks development almost follows the same lifecycle like for the educational process as a whole. In this process are involved not only the textbooks’ authors, but also teachers and students in the testing and implementation steps. Personal learning style affects the collective learning style and chosen teaching methodology. This survey is important not only for the textbook development phase, but also for the educational process implementation in class. And least but not last preferred learning style affects also teachers’ training process, because teachers need to acquire skills and knowledge to teach in such style. Such surveys are more important in STEM courses where not only technologies and course content changes fast, but also the style of information acquisition changes [7].

In order to answer to the perception and learning styles of potential learner, before to start to develop new textbook for studying informatics in 8th grade, we investigated the students’ attitude to study Informatics at school. In the experiment, they were provided fours versions (A, B, C, D) of the same lesson in Informatics for 8th grade. These versions represent four different learning styles according to the Gregorc taxonomy [6]. Version A includes a variety of original materials, but extends to at least twice as many as the required number of pages for standard lesson. Version B covers partially the lesson content, while version C is only in textual form, without any illustrations. Version D best meets the lesson content requirements and restrictions. It has the most images and visual information, thematic characters, somewhat resembling a comics book. Version A is appropriate for students with abstract-random learning style; version B — for students with concrete-sequential learning style; version C — for students with abstract-sequential learning style; version D — for students with concrete-random learning style. The students were asked to answer questions for (1) presentation attractiveness; (2) content accessibility and (3) presentation

structure, using a scale from 1 (lowest) to 10 (highest). In the experiment participated 121 students in total from Sofia High School of Mathematics and the First Private School of Mathematics. The statistical analysis of experimental results are shown on Table 1, and Fig. 2.

Table 1. Statistical Analysis of lessons

	<i>Presentation Attractiveness</i>				<i>Content Accessibility</i>				<i>Presentation Structure</i>			
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
Mean	5.81	6.80	2.68	6.63	6.55	7.09	4.53	7.25	6.56	7.22	4.34	6.23
Standard Error	0.23	0.20	0.19	0.27	0.23	0.21	0.28	0.26	0.24	0.20	0.27	0.25
Median	6	7	2	7	7	8	4	8	7	8	4	6
Mode	8	8	1	10	9	8	1	10	5	8	1	9
Standard Deviation	2.51	2.13	2.02	2.98	2.51	2.30	3.06	2.77	2.59	2.20	2.87	2.69
Sample Variance	6.31	4.56	4.07	8.89	6.30	5.28	9.34	7.70	6.70	4.84	8.26	7.25

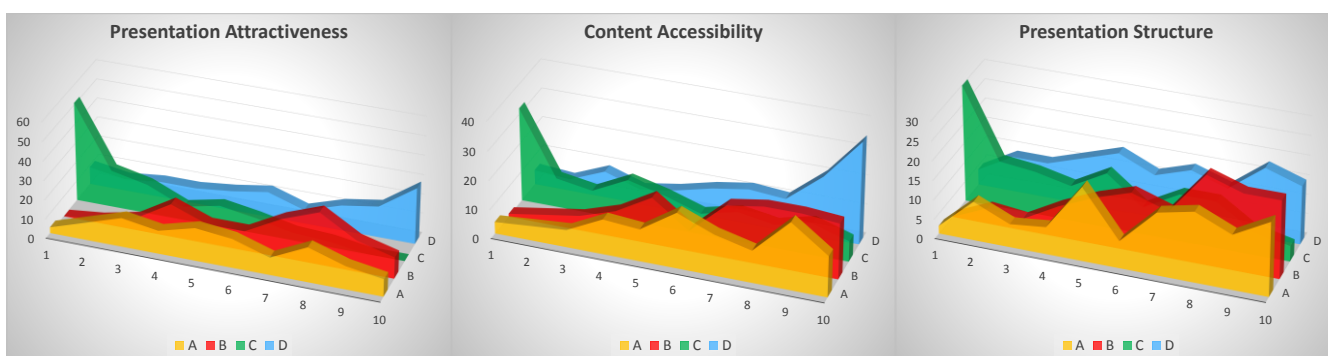


Figure 2. Students' responses for all three criteria in scale [1, 10] for lessons A, B, C and D.

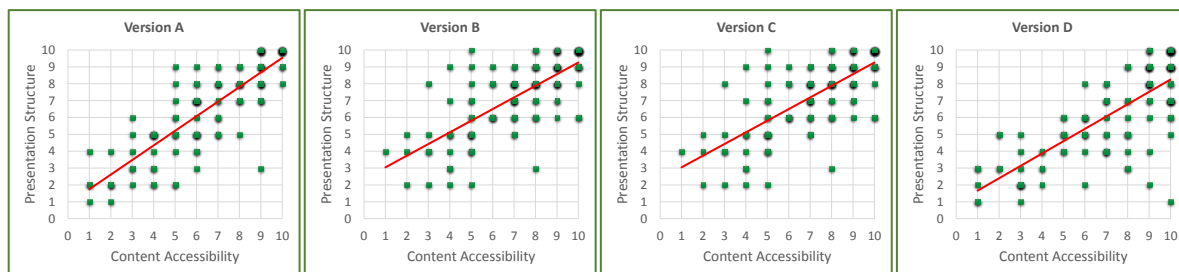


Figure 3. Linear Regression for Content Accessibility and Presentation Structure

The linear regression and correlation analysis show (Fig. 3) that there is strong relation between Presentation Structure and Content Accessibility, but no relation between any of them and Presentation Attractiveness.

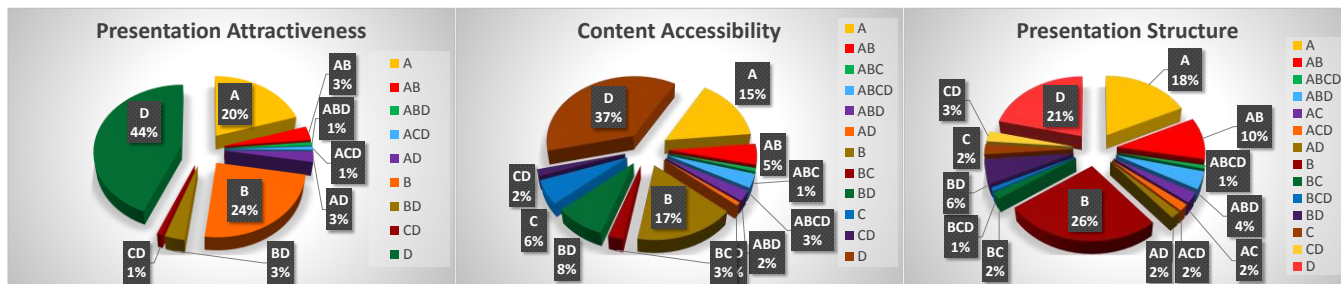


Figure 4. Students' choice of lesson that better fits the criteria for presentation attractiveness, content accessibility, presentation structure according to their learning style

The most desired lessons are B and D (see Fig. 4). Both of them use attractive and accessible content presentation. Moreover, version B is well structured. Some students liked more than one version and ranked several options at the top position in the category.

The topic for four lessons was “Numerical systems and arithmetical operations in Binary numerical system”. The lesson content is too abstract and usage of visual supporting material and Technology Enhanced Learning (TEL) tools is highly desirable. Thus, the students’ choice of lessons in “concrete” learning style (versions B and D) is not surprising.

Students’ expectations are that the course material must be attractive, to capture their attention with a lot of visual information for better comprehension. The diagrams and tables will allow more easily to find procedural information and to summarize the lesson content.

Analyses of the results show that it will be difficult the textbook in traditional form to be appropriate for all learners’ style. Two possible solutions and combination between them could help to solve unsolvable problem:

- to give the teachers power to play with new material freely - training them to have needed competences;
- use the flexibility of e-Learning in secondary school teaching – providing through it possible personalization.

In these two directions are focused teachers’ training courses, which will be described in the next two sections.

NEW REQUIREMENTS FOR TEACHERS’ COMPETENCES

As it is shown in comprehensive study for STEM teachers' competence development in Bulgarian context [8], in order to have powerful teachers, they need to have *subject competences, knowledge about the technologies and pedagogical and methodological qualification for teaching*.

Starting from expectations, we analyzed the subject competences for compulsory subjects Information Technologies, Computer modelling and Informatics.

In primary schools (3th and 4th grades) for the subject Computer Modelling is required basic knowledge about the computer system. Introductory part of course is based on the approach computer science unplugged [9], which aim is to form abstract and algorithmic thinking without usage of computers. The second part of the course requires some computer programming skills. For the new curricula is based on visual programming language like Scratch. These courses are thought by teachers with general education for primary schools. Their university education for teachers does not include such subjects. Thus they need intensive training both in computer programming and in methodologies for teaching the subject. The best method for teaching CM is inquiry-based learning. This method allows to use children curiosity to form himself (herself) knowledge about abstract concepts in the subject.

Compulsory program in Informatics (8th grade) requires knowledge in visual object oriented programming using Java, C#, or Visual Basic. There are two levels of teaching Informatics – level 1 general education (8. grade), and level 2 profiled education (11th and 12th grades). The first level aim is to introduce the main concepts in Informatics and students to understand their importance for the subject. Such abstract concepts like *objects, methods, inheritance, encapsulation*, etc. are omitted from the curriculum at this level. Teachers need fundamental skills in computer programming. For the second level more advanced skills in programming are needed and in addition more abstract concepts are taught in the course. The main objective of this level is early career orientation and development of some professional skills. In addition teachers need to be familiar with databases, information systems, programming of web and mobile applications. The latter two are not included in the compulsory university courses for qualification in teacher in Mathematics and Informatics.

Qualification of teachers in ICT and Digital Competences alongside with classical knowledge and skills for computers systems, computer networks and office tools, require also knowledge for advanced topics as cloud computing, grid computing, supercomputers and security, and personal data protection, included in compulsory curricula in ICT 8th grade. With such rapidly changing technologies even for professionals in the area is too difficult to stay on the top of the wave of such hot topics in ICT. The classical university curricula for teachers’ education do not cover the advanced topics content. In addition, developing digital competences of students includes acquiring skills for solving complex problems including appropriate choice of methods and ICT tools, and presenting a final product in an appropriate format. Achieving such integrated students’ competences needs more advanced pedagogical technologies as project-based or / and inquiry-based learning design and conducting accompanied by interweaving with other STEM disciplines.

In addition to subject competences the teachers need to have the power to use the *ICT in education*

and work in digital environment.

All these requirements challenge the teachers' educational institutions to organize such trainings which not only to "transfer" knowledge to teachers but to *immerse* them into environment and practices that they can experience as students and apply in the classroom as teachers.

NEW TEACHERS' QUALIFICATION COURSERS

The pre-service teacher qualification is expected to be provided by university as major in undergraduate programs. Additional option is to obtain teacher qualification as second specialty to the major undergraduate program (e.g. in Computer Science, Informatics, Software Engineering or Information Systems). According to the Ordinance on National requirements for acquiring professional qualification "teacher" [10] are suggested minimal academic hours (AH) for subjects: *Pedagogy* (60 AH); *Psychology* (60 AH); *Pedagogy in... (Specific subject)* (90 AH); *Inclusive education* (15 AH); and *ICT in education and work in digital environment* (30 AH).

In the Law for pre-school and school education [11] are defined different types of qualification in teachers' career development:

- Mandatory qualification for in-service teachers (48 academic hours per attestation period), measured by ECTS credits.
- Mandatory internal institutional qualification (16 academic hours per year).
- Attestation period of 4 years for all pedagogical specialists.
- Possibility for professional development for all pedagogical specialist.
- Opportunities to attract young people to work as teachers by introducing of new positions: trainee-teacher and mentor teacher.

According to the content, the courses in the National register of teachers' qualifications programs [12] can be grouped as follows:

- subject matter course, dedicated to the new curricula in specific subject and class;
- innovative methods of teaching;
- applications of ICTs in specific subject in education.

In addition to the official qualification programs series of non-formal methods are provided, like: webinars, special web portals for teachers support with teaching materials, designed lessons, tutorials for self-education, forums in social media, etc.

Responding to the recent changes in the National policy framework, Faculty of Mathematics and Informatics, Sofia University, organizes short term qualification courses for teachers in ICT and Informatics as well as for STEM teachers on using ICTs and innovative teaching approaches in education.

The special challenge is design and delivery of qualification courses to in-service teachers. During a national-wide workshop, with participation of teachers, teachers' educators and policy makers, there were extracted the main requirements for efficient teachers' trainings design and delivery [8]. All the stakeholders united around the idea of interdisciplinary education based on the same innovative methods (inquiry-based, project-based learning) which is expected teacher to apply in their practice (meta-trainings). The participants shared also that without efficient evaluation and assessment of educational process it is not possible to achieve high quality in STEM education.

According to the learning activities, the most of the participants prefer active practical learning process instead of the standard one, based on lectures and formal exams.

The most important requirements, related to the forms of teachers' training courses are:

- Face-to-face or blended learning
- Online courses – as a current support, and as an archive for long term use.
- Balance between learning at work place (school) and out the door courses – regional, national workshops as environment for sharing ideas and experience.

They strongly agree also on the use of online training courses content and specialized software tools for support of the STEM specifics.

After the careful analysis of the stakeholders' expectation there were defined a flexible framework for short-term teachers' trainings, presented in Table 2.

The presented structure for blended-learning tries to find a balance between the need for learning without leaving the workplace and need to be involved in the same innovative learning methods that are taught.

Table 2. Short-term teachers' training framework

Session / format	Face-to-face session	Distance learning session	Face-to-face session (optional)
Activities	• Ice-breaking • Motivation • Meta-training • Forming community	• Literature review • Lectures • Individual assignments • Collaborative assignments • Reflection	• Plenary presentation of the final product • Reflection and feedback

During the face-to-face session, the participants have opportunity to getting knowing each other and to form strong teacher's community which to support them further not only during the distance session, but also for long-term period during their practice. The session provides environment to teachers to get in role of students and to experience, feel and reflect to innovative methods of teaching. As most of the Bulgarian teachers have very little experience with e-learning, during this session they are familiarized with general and specialized e-learning platforms and tools which will be used in distance learning phase. As a result, they overcome communication barriers among the group as well as the fear of new technologies.

The face-to-face session creates a base for effective and efficient implementation of the distance learning session. To achieve the learning goals, this session shall be structured in e-learning platform, providing the common tools for administration, communication, sharing learning resources, conducting interactive assignments, tracking achievements and evaluation results. It would be benefit if the chosen platform provide tools for management of group work. Specialized ICT tools, related to the particular subjects (virtual labs, project management tools, technologies for observation physical, chemistry or biology phenomena or measurement quantities, etc.), shall be easily integrated in the e-learning platform.

Addition benefit of using e-learning platform during both phases is providing an archive for long-term use not only of learning content but of all the generated experience, expressed in group and individual work, communications and reflections, which can be accessed and explored at any time and any place.

A final face-to-face session is optional and its' presence depends on the duration of the course and trainers' possibilities for second face-to-face meeting. As it provides opportunity for sharing achievements and experience in front of the whole group, and, as a consequence, to increase trainees self-confidence, as an alternative, it can be implemented as webinar at the end of the distance phase.

FRAMEWORK FOR EMPOWER TEACHERS

The presented framework was applied in series of STEM teachers' trainings related to the recent National policy framework implementation.

Table 3. compares realizations of two of them – first one is subject-oriented for computer science teachers and second one – innovative pedagogy practices-oriented interdisciplinary course for STEM teachers.

Table 3. Teachers training framework implementations

Course topic / participants	Duration	Short description	E-learning platform	Key e-learning tools
The new curricula in informatics in 8 th grade	32 AH f2f: 16 Dist.: 16	• Introducing participants • Sharing previous experience and expectations • Brief presentation of each topic • Providing good practices examples • Group discussions on challenges • Individual task work • Project work	Moodle (https://moodle.org/)	• Participants management • Learning content management • Assignments • Forum • Gradebook • Java IDE (Eclipse)
Open-air lessons: myth or no...	32 AH f2f: 16 Dist: 16	• Role play – teachers acts as students in open-air competition covering following tasks: ○ Solving a riddle pointing to a hidden treasure - part of a crossword puzzle; ○ Solving crossword;	Dojo-IBL (https://dojo-ibl.appspot.com)	• IBL design tool • Discussions tool • List tool • Reflection tool • Mobile devices and apps: ○ Map

	○ Counting of plant species ○ Calculating the resort area ○ Calculation of the density of plant species ● Reflection on the activities, time and role distributions, team play ● Study of the normative framework, related to organizing open-air lessons ● Study of good practices of open-air learning ● Discussing special educational need students involvement ● Design of open-air learning process		○ Calculator ○ Search engine ○ Digital camera
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Both examples provides e-learning platforms, appropriate for the course content and participants, as well as tool, related to the particular training. Both represent the teaching methods that are expected teachers to apply in their lessons with students. The Moodle platform, chosen for the first training is open-source and accessible for secondary schools too, providing a set of tools which correspond with the school practices of teaching and assessing. The Dojo-IBL platform is designed especially for inquiry-based learning planning and implementation, integrating different inquiry-based learning models.

Working with them is not only provides a learning environment for teachers but also cultivates their habits to use e-learning in practice, help them to overcome challenges related to new ICTs and to use the platforms in their teaching practices also.

In 2016 the first course in ICT 5th grade was released. In 2017 were released courses for 6th and 8th grade in ICT, and the course in Informatics 8th grade.

The very positive feedback immediately after the training and later, after application of the acquired competencies in the classroom, approve the expected added value of implementation of described framework for blended teacher's e-learning (Fig. 5).

Teachers' Training course in ICD 5th-7th grade

Now I believe it is fully realistic to organize such education with my students – it definitely will increase their interest and motivation in biology. Participating in this training I saw my weaknesses and fields where I have to learn more and more. But I'm not frustrated by this – my team valued highly my creativeness and I felt confident working on tasks.

Teachers' Training course in Informatics 8th grade

I was terribly afraid of computer science – so far I have taught IT only, I did not know either Java or C #. During class 8th I found out that every hour I feel more and more confident and confident. This is the learning style I have dreamed for my students. After one academic year, I can say that even though we did not have time for the whole program, they struggled with their projects, read extra material, and even helped me to find out how their programs could be improved. They were already asking me if we would continue to study computer science next year and, were disappointed. They asked for elective courses. Please inform me if you organize short-term out-of-school training. I will be very grateful!

Figure 5. Feedback from teachers finished short-term qualification courses at Sofia University

CONCLUSION AND FURTHER WORK

Described editions of provided teachers training framework shows that it is capable to cover National policy requirements for teachers' competence development as well as the stakeholders' expectations. E-learning provides opportunity for efficient and effective teachers' trainings design and implementations. The balance between distance and face-to-face activities is important. The flexibility of the platform, content and pedagogical approaches allow trainers to reflect in time to different learning styles of trainees. Provided combination of pedagogical approaches and e-learning tools acts not only as learning environment but also as meta-training – the trainees transfer the acquired practices in their daily teaching practices at school. Our experience shows that solving of unsolvable challenge is possible and e-Learning has key role in it.

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