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Teacher Attitudes to Professional Development of Proficiency in the Classroom Application of Digital Technologies

Štefan Karolčík[1], Elena Čipková[1] & Ian Kinchin[2]

[1] Department of Didactics in Science, Psychology and Pedagogy, Faculty of Natural Sciences, Comenius University, Bratislava, Slovakia

[2] Department of Higher Education, University of Surrey, Senate House, Guildford, United Kingdom

Correspondence: Štefan Karolčík, Department of Didactics in Science, Psychology and Pedagogy, Faculty of Natural Sciences of Comenius University in Bratislava, Bratislava, Mlynská dolina, Slovakia. Tel: 421-2-6029-6314. E-mail: karolcik@fns.uniba.sk

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Abstract

The paper deals with research focused on the opinions and attitudes of biology teachers on the application of digital technologies in the process of learning and teaching. The respondents were teachers, who participated in the national project called "Modernization of the Educational Process in Elementary and Secondary Schools" realized in Slovakia between 2008–2013.

We briefly describe the course and the contents of individual modules, which were focused on the development and acquisition of specific skills in the field of effective use of modern educational technology. The key role in the methodical preparation of teachers was played by the 3rd module, which aimed to present the teachers with the examples of meaningful and methodically well prepared application of digital technologies in the teaching process, especially in connection with current digital educational contents and the curriculum of biology subject.

The second part of the study includes analysis of satisfaction among the course participants with the content, level of expertise and difficulty level of the course, as well as the analysis of their opinions and attitudes on usability of created and available model methods in the real school practice. In conclusion, we present suggestions which could, facilitate improving the quality of biology teaching in schools, in order to reflect the real needs of society.

Keywords: technology-enhanced learning, teaching methods, education technologies, teacher training, education

1. Introduction

Today–especially in the eyes of public, parents, as well as many teachers–the use of digital technologies in the teaching process is connected with a modern and successful school, which can well prepare its students for work and life in the knowledge society. Although many authors connect modernization of the educational process with digital technologies and their application in the teaching process, e.g. Osborne (2013), Al-Smadi, Gütl, and Kannan (2010), del Campo, Negro, and Núñez (2012), in agreement with authors (Ogawa, 2010; Navarro, Canaleta, & Solé, 2012; Veselský, 2005) we are working within a framework that assumes equal importance to emphasis on the application of constructivist principles and the use of procedures and methods in the teaching process, which provide students with opportunities for spontaneous exploration, problem solving, examination of various phenomena by experiments, discovering principles, and generalization on the basis of the above mentioned cognitive activities. Many studies have shown that the application of digital technologies in the teaching process increases the students´ motivation and their interest in the curriculum and a given subject (Jeet-Kaur & Sharma, 2013; Owusu et al., 2010; Nagy et al., 2012), and it also increases the level of understanding of the curriculum (Y. Cheng, J. Cheng, & Chen, 2012; Sun, Lin, & Yu, 2008; Basturk, 2005; Çepni, Taş, & Köse 2006). However, a teacher and his/her professional skills play a decisive and irreplaceable role in the successful and effective implementation of digital technologies in the teaching process. It is particularly the teacher who selects the teaching strategies, teaching methods and procedures for the purpose of motivation, activation of students for learning, as well as better knowing and understanding of nature by students. It is necessary that the teacher critically assesses the available teaching aids and properly determines the scope of

their application in the teaching. To be able to prepare their students for life, they must know and respond to new needs and expectations of the society and purposefully develop competences of students in areas which appear to be extraordinary useful and important for them to assert themselves in their lives (Karolčík & Čipková, 2014).

Barriers to the efficient integration of digital technologies to the teaching process can be summed up in three main aspects (headings): lack of teacher's confidence, lack of teacher's competence and lack of access to resources (BECTA, 2004; Bingimlas, 2009). In addition to these barriers, the BECTA's review of literature describes also other reasons why teachers have difficulties with integration digital technologies in their work, such as lack of time, technical problems, resistance to change and negative attitudes, no perception of benefits, impact of public examinations, age differences and gender differences (BECTA, 2004). Barriers to successful implementation of technologies in curricula can be divided into external (first-order), such as limited sources and lack of technical support, and internal (second-order), including teachers' attitudes towards digital technologies (Ertmer 1999; Snoeyink & Ertmer, 2001). Research indicates existence of complex mutual relations between these two levels, as well as between the barriers within these levels. Ertmer (1999) states that it is not reasonable to provide a large number of devices (technologies), if teachers do not trust these technologies and do not hold attitudes required to change their class practices. According to other authors, however, the degree of trust, and thus the rate of using the technologies, is directly influenced also by accessibility of digital technologies to teachers at home (Ross et al., 1999; M. Cox, Preston, & C. Cox 1999). Factors affecting teachers' trust in technologies include also the amount and quality of available trainings (Pina & Harris, 1993; Lee, 1997; Brand, 1997). Intensity of technology use by teachers is also affected by the content and focus of attended trainings. It is assumable that trainings which lack the pedagogic aspects of digital technologies use in teaching will not be a success (Veen, 1993). It is also important that the trainings comprise opportunities to obtain and enhance the digital technologies skills (Preston, M. Cox, & C. Cox, 2000).

Hew and Brush provided a detailed analysis of the barriers to the technology integration in the teaching process published in the literature over the period between 1995 and 2006. In the analysed studies they identified six categories of barriers, including four that they classified as first-order barriers (e.g., resources, institution, subject culture, and assessment) and two as second-order barriers (e.g., teacher attitudes and beliefs; knowledge and skills). The most frequently cited barriers impacting technology integration in the teaching process were: 1) resources, 2) teachers' knowledge and skills, and 3) teachers' attitudes and beliefs (Hew & Brush, 2007).

According to McCain, however, the use of technology in the classroom is not the critical issue that the education faces in the 21 century. The issue of foremost importance is to develop thinking skills in students so that they are able to utilize the potential of technologies to solve problems and to do useful work (McCain, 2005).

2. Objectives, Agenda, and Course of Education of Biology Teachers

The national project called Modernization of the Educational Process in Elementary and Secondary Schools was co-financed from the EU sources and implemented in the training centres in Slovakia in the period between 2008 and 2013. The main objective of the project was the innovation and modernization of teaching procedures, methods and forms of teaching supported by available digital technologies. Each course participant received a project laptop and at their schools one classroom was supplied with new technology (1 data projector, 4 to 6 PCs) (Karolčík & Čipková, 2014). Due to its nature, focus, number of participating teachers, as well as the territory covering all regions of Slovakia, it was an exceptional project with the impact on the entire country, unrepeatable in the new history.

Education of biology teachers, as well as teachers of other subjects, was carried out in three stages (modules); it included the presentation form and the distance form of education. It was preceded by the preparation stage, lasting approximately one year, during which the group of experts, consisting mainly of biology teachers, methodologists, and experts in pedagogy with long-lasting experience in the use of digital technologies in the teaching process, prepared the structure and content of the course in individual modules. The expert group also prepared a detailed agenda, including the course schedule, learning activities, and assignments for the education participants. Based on the TPACK framework (Kinchin, 2012), we compiled the course agenda, while focusing especially on deepening of their digital knowledge (Module 1 and 2) and pedagogical knowledge (Module 3), as the course target group included teachers from schools with the sufficient content knowledge, awareness of the curriculum and of the problems related to students' understanding of biological phenomena and principles.

The course content was supplemented with methodically thoroughly prepared models of lessons, suggestions of suitable incorporation of a selected digital teaching aid in the course agenda and detailed descriptions of available equipments or technological solutions used in practice. The expert group also prepared a detailed agenda with the time schedule of education, learning activities and assignments. Concurrently with the creation

of methodologies, the national network of training centres was built and selected instructors were trained - they were selected mainly from teachers with long-lasting experience in the implementation of digital technologies in the teaching process. Unlike teachers of humanities-oriented subjects (e.g., Slovak Language, History, Art), Biology teachers included sufficient number of teachers who had been experimenting in their teaching practice with digital technologies even before enrolling in the course. Therefore, the selection of lecturers from among Biology teachers was much easier and the selection criteria were more demanding.

Table 1. Number of course lessons in individual education modules.

	Module 1	Module 2	Module 3
Presentation form	12*	18	30
Distance form	6	6	34**
Total in module	18	24	64

Note. *slightly advanced, **of these, 10 lessons for the final work.

3. Modules 1 and 2

The main objective of the Module 1, consisting of 6 or 12 presentation lessons, was to achieve approximately the same level of general digital literacy among all teachers participating in the project. The core of the educational activities consisted of assignments verifying the achieved level of awareness in the basics of the work with programs grouped in the so-called MS Office package. The content of course was supplemented with available tools of electronic correspondence and online communication. The emphasis was also put on issues related to safety of work in the virtual environment, respecting the ethical code and minimisation of risks of inappropriate behaviour of students. The course agenda took into consideration the achieved level of teachers´ skills and for the advanced users the mandatory scope of the course agenda was reduced.

While all the teachers passed the Module 1 education during 2009, Module 2 education was carried out continuously during a 3-year period: 2010-2012. The content of the Module 2 education was focused on modern didactic technology in a teacher's work. The education was carried out in the scope of 18 presentation lessons, at which teachers acquired knowledge in the field of work with modern didactic technology. The course agenda focused on primary processing and publishing of digital image, sound, video, installation and functional interconnection of peripheries, the participants tried working with an interactive whiteboard, tablet and the voting system. Selection of other equipments and technologies depended on a teacher's qualification. Biology teachers paid attention to aids enabling examination of the surrounding world by students using a digital microscope and computer-assisted experiments. In all the performed educational activities, the emphasis was put on methodically appropriate, thoroughly prepared and meaningful use of the presented technology in the process of teaching and learning. Teachers had to create several scenarios in which they presented in details their strategies how to apply the didactic technology. Teachers proved their preparedness to use selected digital technologies by practical connection, installation, calibration, launching and control of selected equipment (device), or by testing the functionality of the recommended software applications (Karolčík & Čipková, 2014).

In Modules 1 and 3, teachers obtained especially the skills of working with digital technologies (digital knowledge). Only marginally they were dealing with possible applications thereof in teaching.

4. Module 3

The key module of the education of teachers engaged in the national project "Modernization of the Educational Process in Elementary and Secondary Schools" was Module 3, which represented the most important part of the methodical preparation of teachers from the point of view of the specialisation of a course participant. In terms of the TPACK framework (Kinchin 2012), this module was focused on acquisition and interconnection of the knowledge from all three areas - technology, pedagogy, and content. The list of topics in Module 3, which were included in the TPACK framework, is presented in graph 1.

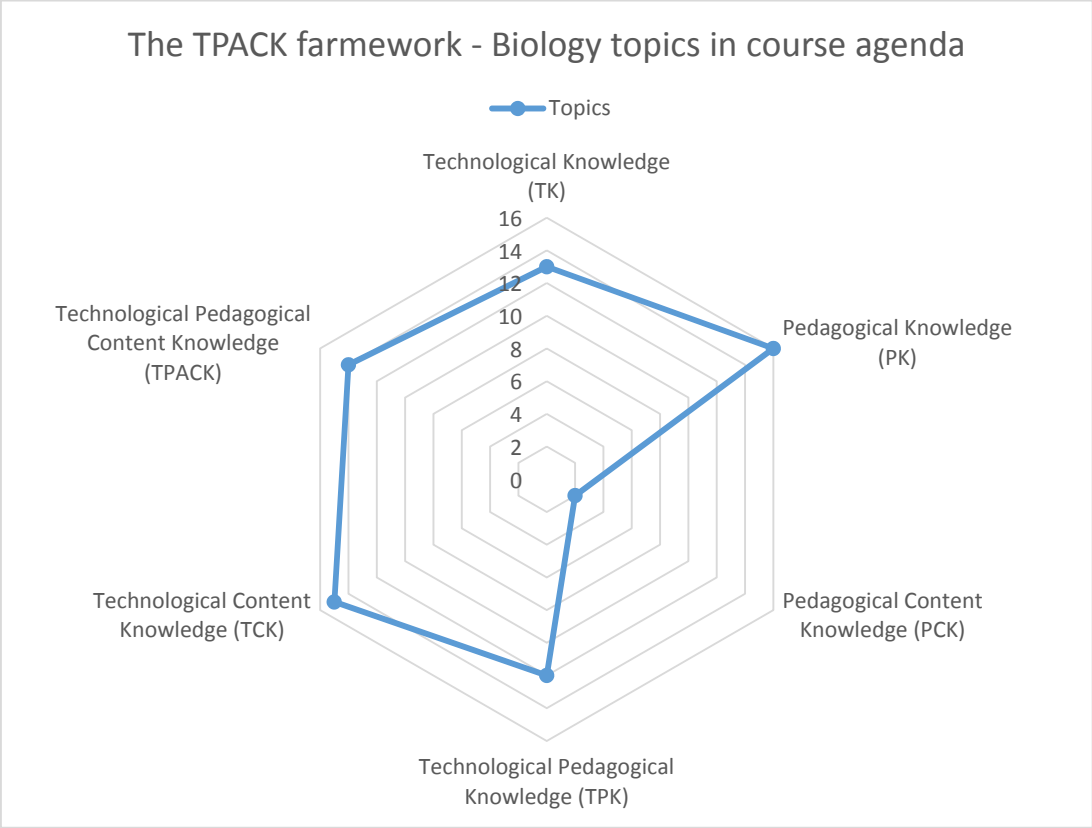

Figure 1. Biology topics in the course agenda in terms of TPACK

The course agenda consisted of two topics. The first topic was common to all course participants. It contained more general topics on the transformation of school and transformation of classrooms in a society, where digital technologies take the primary role when dealing with everyday situations. Teachers were discussing the rate of inevitable systematic changes in their work, new education conceptions, teaching means and transformation (digitalization) of teaching aids. They also paid attention to possible applications of selected forms of education organizing and progressive teaching methods which, in terms of pedagogical research, bring interesting education results (Karolčík & Čipková, 2014).

The second topic, with which biology teachers were continuously becoming familiar within Module 3, was focused on specific features of the use of digital technologies in biology subject. While preparing the course agenda, the expert group was considering mainly the development of dominant key competences of students in given subject. It focused on domestic and mainly on foreign documents and strategies, such as Recommendation of the European Parliament and of the Council on Key Competences for Lifelong Learning (Official Journal of the European Union, 2006), or ICT Across the Curriculum–ICT and Science (Department for Education and Skills 2004). They also considered the experience of specialists acquired by implementation of digital technologies in the biology teaching process. For the purpose of education the expert group prepared the examples of lesson models containing the use of digital technologies, which are in terms of biology teaching desirable and well usable in several biology topics and topic units prescribed by the curriculum. When selecting the key technological solutions the team of specialists focused mainly on those, which are more or less available in conditions of Slovak schools, and which allow to achieve better education results in combination with appropriate methods and forms of work. Another important thing was to show biology teachers the possible uses of digital technologies not only during teaching in the classroom, but also directly in nature and in the surrounding of school, where the technologies are used for collection, analysis, evaluation and exchange of acquired information and data. When selecting the software solutions, the authors of the course agenda preferred more universal, freely available, freely distributable, so-called open source software products. Through complex technological solutions the teachers had opportunity to familiarize themselves with learning environment Planet of Knowledge, which is available for all elementary and secondary schools in Slovakia.

Biology teachers could thus become more familiar with the work with interactive whiteboard and software

applications supplied together with interactive whiteboards (ActivStudio, Flow!Works, SMART Notebook), digital microscope, computer aided science laboratories, e-learning educational environments (LMS Claroline, LMS Moodle), videoconference solutions, simple and easy to operate applications for the creation of interactive tasks and tests (e.g. Hot Potatoes, MS Word) etc. Another interesting thing for teachers were also the demonstrations of use of blogs and social networks in the biology teaching process - which are really popular among students. Apart from a brief characteristics of the most important control tools and elements, during the preparation of biology teachers the strongest emphasis was put on efficient and meaningful use of given technology in the teaching process in school conditions. A critical and professionally qualified attitude to the rate and form of appropriate use of a particular technology in the teaching process was expected from teachers.

The course agenda contents differed according to the degree and type of school, where biology teachers work. Differences were also in the offered methodologies, selection of recommended digital technologies, methods and forms of work, as well as in the selection of processed biological problems and topics.

In the assignments and tasks, which were designed for biology teachers and which verified their achieved level of skills, it was always stressed that only critical, thoroughly methodically prepared, age-adequate and methodically justified use of created digital teaching aids and selected technologies can improve the quality of biology teaching in elementary and secondary schools. The inspiration for teachers was represented by detailed scenarios of lessons supplemented with number of original teaching aids, interactive worksheets, electronic exercises and methodical manuals how to work with given technology and software so that its application brings the best education results. Biology teachers have unlimited access to the created methodologies via the project's digital library.

5. Research Methodology

The research was carried out with the group of 342 biology teachers–participants of the national project of Modernization of the Educational Process in Elementary and Secondary Schools. They were qualified teachers with various durations of pedagogical practice, working in schools in various regions of Slovakia. All the teachers have successfully completed the course by elaboration of the final work, the defence thereof, and the final exam. Thus they proved the adequate level of knowledge and experience to discuss the appropriate and methodically well prepared application of digital technologies in the teaching process. The research was carried out in the period of three years (2011–2013) in form of an electronic questionnaire available online. Respondents were filling out online questionnaires after completion of the course. The questionnaire had a specific structure and contained 16 questions, of which 13 items were scaled and 3 items were open questions. The items were aimed at identification of the degree of satisfaction of participants with the execution and content of the course, as well as at subjective evaluation of processed scenarios of lessons and methodologies in terms of real school practice. The structure of items considered the statistical processing possibilities. In the calculation of the questionnaire reliability we used the statistical parameter Cronbach's alpha with the value of 0.785.

The research was focused on two main questions:

1) How do biology teachers evaluate the completed course agenda?
2) Which of the presented digital technologies are regarded by biology teachers as the best usable for the real teaching in schools?

6. Results and Conclusions

Just as in Module 2, in Module 3 the education was carried out continuously in years 2010 to 2012. The number of all the participants who passed the respective number of presentation meetings and fulfilled the determined tasks was 6,670. Out of these, 342 teachers were biology teachers. Most frequent comments of participants to the education in Module 3 were aimed at the organization of trainings, especially allocation of the assigned training centres in terms of distance from the place of their work. Another group of comments was related to a long period in which the education was carried out. Majority of participants, however, expressed extraordinary satisfaction with Module 3.

The proposed education agenda for biology teachers in Module 3 was mainly focused on the development of science and digital competences of students. As part of the development of digital competences these were mainly: a) the search and assessment of information, b) processing of information.

Table 2. Evaluation of answers of all participants and participants of education in biology subject to the question: How do you evaluate the contents of the Module 3 training?

	Frequency Biology	Frequency All	Percent Biology	Percent All	Valid Percent Biology	Valid Percent All	Cumulative Percent Biology	Cumulative Percent All
excellent	124	2167	36.3	44.2	36.3	44.2	36.3	44.2
good	191	2280	55.8	46.5	55.8	46.5	92.1	90.8
satisfactory	25	409	7.3	8.4	7.3	8.4	99.4	99.1
rather unsatisfactory	1	38	0.3	0.8	0.3	0.8	99.7	99.9
unsatisfactory	1	4	0.3	0.1	0.3	0.1	100	100
Total	342	4898	100	100	100	100		

Teachers mostly appreciated the purposeful content focus of the education on the possible uses of digital technologies in the biology subject, since they could immediately apply the acquired knowledge in their pedagogical practice. The research confirmed that the opinions on the contents of Module 3 (Table 2) of the participants among biology teachers are the same as the opinions of majority of participants on this question. As much as 92.1% of participants of Module 3 in the biology subject assessed the overall level of training as good (55.8%) or high (36.3%). The introductory part of Module 3, focused on the generalising information and innovative approaches to the modernization of education supported by digital technologies (Table 3), is regarded as very useful by more than half (51.5%) of participants among biology teachers. Very pleasing were also observations regarding the evaluation of the overall level of training in Module 3, which was assessed by almost a half (45.3 %) of biology teachers as excellent and by 48.5 % as good. In the context of high burden of the training, with regard to its content, scope and required skills (67.3% of participants among biology teachers assessed the level of burden of Module 3 as high or rather high), these results prove that biology teachers can appreciate even professionally very demanding education and regard its focus and content as meaningful and beneficial for their pedagogical activities.

Table 3. Evaluation of answers of all participants and participants of education in the biology subject to the question: How useful is for you the "Common part of Module 3" for the more complex understanding of the issues regarding modernization of education supported by digital technologies?

	Frequency Biology	Frequency All	Percent Biology	Percent All	Valid Percent Biology	Valid Percent All	Cumulative Percent Biology	Cumulative Percent All
very useful	176	2849	51.5	58.2	51.5	58.2	51.5	58.2
partially useful	112	1365	32.7	27.9	32.7	27.9	84.2	86
more useful than unuseful	48	576	14	11.8	14.0	11.8	98.2	97.8
little useful	6	96	1.8	2	1.8	2	100	99.8
unuseful	0	12	0	0.2	0	0.2		100
Total	342	4898	100	100	100	100		

Also in case of participants of education in the biology subject, high levels of the instructors' work were confirmed. As much as 80.4% of biology teachers (Table 4) assessed the instructor's quality in the highest category, i.e. the high level. Their proficiency, preparedness, as well as overall approach to the obligations was assessed as good by 16.4%. Altogether, almost 97% of education participants in the biology subject reported they were very satisfied with work and professional approach of their instructor. With regard to this, it is necessary to

point out that instructors had to pass a 3-day special training and the applicants were selected mainly from among innovative biology teachers experienced in the application of digital technologies in the teaching process. We can assume that particularly this fact had a significant impact on their collegial approach and often appreciated ability to understand specific problems (technical equipments in schools, organization of lessons, etc.) that are directly related to the application of technologies and innovative approaches in the teaching process.

Table 4. Evaluation of answers of all participants and participants of education in the biology subject to the question: Assess the instructor's level (expertise, preparedness, approach)

	Frequency Biology	Frequency All	Percent Biology	Percent All	Valid Percent Biology	Valid Percent All	Cumulative Percent Biology	Cumulative Percent All
high	275	3651	80.4	74.5	80.4	74.5	80.4	74.5
good	56	1046	16.4	21.4	16.4	21.4	96.8	95.9
satisfactory	9	179	2.6	3.7	2.6	3.7	99.4	99.6
little satisfactory	2	17	0.6	0.3	0.6	0.3	100	99.9
unsatisfactory	0	5	0	0.1	0	0.1		100
Total	342	4898	100	100	100	100		

The successful realization of teachers' education and resulting modernization of the educational process in elementary and secondary schools require professionally and methodically well prepared teaching materials. Methodically processed examples of selected biology curriculum topics for elementary and secondary schools represent, in terms of their contents, the largest part of the prepared teaching materials. They contain model examples of the utilisation of available digital technologies, innovative methods, approaches and concepts in various forms and learning stages proposed by the expert team. They include also methodical instructions, practical advices and recommendations for the application of a particular technology, software or applet. In exemplar methodologies, the emphasis is put especially on active engagement of students in the learning process, development of their natural sciences literacy, key competences, critical thinking and creativity. The emphasis is put on the practical work of students. Students are required to formulate the problem, obtain, analyze, assess and generalize information, correctly interpret the data, graphs, tables, be able to cooperate, discuss, argue and make conclusions.

A detailed analysis of answers of participants in the education in the biology subject indicates a high level of satisfaction with learning materials prepared by experts and the agenda of Module 3 education.

From the biology teachers' point of view, practical examples of methodologies for appropriate use of digital technologies and electronic learning environments in teaching biology represent the most usable part of the entire course for their pedagogical practice. Examples of methodologies for the use of digital technologies in the biology teaching process, which represented the focus of the educational program and learning materials of Module 3, were assessed extremely positively by 23.4% of teachers (Table 5). Another 4.1% of teachers assessed the education very positively and they supposed that in terms of real school practice all the selected technologies and innovative approaches are usable in the teaching process. 8.5% of teachers did not give any answer to the question regarding the best usable digital technology in the real school practice. The teachers stated the use of interactive whiteboard (28.9%) and learning environment Planet of Knowledge (17.8%) as the most usable part in the course content. As we expected, the teachers´ responses copied mainly the availability of selected technologies and software applications in school, since in recent period the interactive whiteboards and learning environment Planet of Knowledge were centrally delivered to schools. The teachers of elementary schools saw the benefits of interactive whiteboard mainly in the motivation stage of the lesson and also when improving and practicing the curriculum. They especially appreciated the possibility of creating various interactive exercises, which are interesting and motivating for students. The teachers of secondary schools appreciated the benefits of interactive whiteboard in connection with the use of learning environment Planet of Knowledge mainly during exposition and fixation of the curriculum.

Table 5. Percentage of answers of biology teachers to open question: What from the education agenda of Module 3 do you assess as the best usable in the real school practice

	Count	Column %
Examples of the use of interactive whiteboard	99	28.9
Examples of methodologies for the use of digital technologies in the biology teaching process	80	23.4
Examples of the use of learning environment–Planet of Knowledge	66	19.3
Examples of the use of presentation and animation	45	13.2
Examples of the use of LMS Claroline and LMS Moodle	39	11.4
Educational projects and project learning	38	11.1
Examples of work with specialized text	29	8.5
Answer not stated	29	8.5
Work with digital microscope, examples of methodologies	27	7.9
Hot Potatoes, examples of the use	16	4.7
Everything	14	4.1
Website address book	13	3.8
Examples of the use of voting devices	6	1.8
I cannot assess	6	1.8
Examples of various forms of education	6	1.8
Other (frequency less than 6)	39	11.4

Material and technical support of schools is also reflected in teachers´ responses to second open item (Table 6). By detailed statistical analysis of question - what from the agenda of Module 3 education do they regard as not usable in the real school practice - we found out that teachers most frequently stated examples of technologies and software solutions that are sporadic in Slovak schools. The teachers justified their answers mainly by insufficient technical and financial provision of schools, in which they work. The proof of this is also the opinion of teachers (21.6%), who said that everything is usable (nothing is unusable), if the school is technically equipped. As the least usable technology in school practice the teachers regard videoconferences (16.4%), which is probably due to high technological and technical demands of videoconferences realization (charges for licenses of professional videoconference applications, speed of the internet connection...), as well as due to the amount of time required for organizational and content preparation of educationally oriented videoconference. 15.8% of biology teachers did not write any answer to this question. Out of these more than 90% (14.3% of all participants) reported high values of the rate of satisfaction in question related to satisfaction with the content of education.

Table 6. Percentage of answers among biology teachers to the open question of what from the agenda of Module 3 education do they regard as not usable in the real school practice

	Count	Column %
The unusable aid is the one for which the school has no material and technical support	74	21.6
Videoconferences	56	16.4
Answer not stated	54	15.8
Examples of the use of voting devices	31	9.1
Examples of the use of remote virtual laboratories	27	7.9
I cannot assess	25	7.3
Use of blogs in the teaching process	13	3.8
Remote Accessible Field Trips	11	3.2
Work with digital microscope, examples of methodologies	10	2.9
Computer aided science laboratory	6	1.8
Other (frequency less than 5)	35	10.2

The last open question was examining the opinions among biology teachers on which facts they were missing in the course content. This question was not answered by more than a half of teachers (51.5%). However, if we take into consideration those who did not respond at all to open questions (1.8%), all other participants expressed their opinions on the most or the least usable digital technologies in previous two questions. Almost one quarter of participants among biology teachers (24%) stated that they do not miss anything in the content of the course, as it was sufficient and it offered all the necessary information and knowledge. 13.5% of biology teachers did not feel sufficiently competent, therefore they were not able to assess which innovative approaches and modern technologies could be included in the content of textbooks. Approximately 1.5% of teachers would appreciate other, unspecified practical examples on how to use digital teaching aids in the biology teaching process, assignments and experiments.

7. Conclusion

Opinions and attitudes of teachers who passed and succeeded in the course, focused on the development of teaching skills in the field of efficient and purposeful utilisation of digital technologies in the Biology teaching process, indicate that despite high level of demandingness of the course, they regard the contents thereof as very useful. The teachers expect that together with digital technologies and educational software they will obtain also high-quality methodical directions and well prepared examples of teaching activities, including examples of appropriate and efficient use of given teaching aid in the teaching process.

The analysis of teachers' answers to the items of questionnaire confirmed that for successful implementation of digital technologies and innovative approaches in the educational process in elementary and secondary schools it is equally important to focus on all three areas - building of technologies infrastructure, methodical support of the teaching process in the form of well processed examples of educational activities and support of teachers in their further education and in the development of professional skills. The opinions of teachers on the possible uses and benefits of digital technologies in practice are strongly influenced by the quality of technical and technological infrastructure. The community of biology teachers highly appreciated the selection of digital technologies and didactically methodically processed examples of selected biology curriculum topics for elementary and secondary schools. From presented digital technologies the biology teachers regard as the best usable in the school practice mainly those, which are available in their school.

In accordance with authors (Ross et al., 1999; M. Cox, Preston, & C. Cox 1999), we can therefore state that the degree of trust in technologies and the rate of their use in teaching are strongly affected also by a teacher's personal approach to digital technologies. In spite of the fact that teachers acquired the digital knowledge, as well as methodically processed examples of their efficient integration in the curriculum, evaluation of the benefit of a particular digital technology, in terms of teaching, was closely connected to its accessibility in a class.

Another equally important element participating in the successful course execution is lecturers. They were very positively rated not only for their expertise and professional approach, but also for their specific experience with the digital technologies integration to support the education objectives.

Apparently, teachers negatively perceived a long time interval between Module 1 and 2. It is therefore necessary to provide a systematic training of teachers with sufficient amount of time to obtain the required knowledge and subsequent implementation of technologies into their own education areas. Teachers also objected to the fact that the course took place in training centres. For the purpose of more successful integration of technologies in the teaching process, it would probably be more appropriate to organise courses directly at schools, where teachers can discuss potential transformation of their schools, classes, and teaching processes with their colleagues and school management. On the other hand, such concept of trainings eliminates the development of cooperation between schools and teachers within the region.

Within the further research, it was interesting to examine barriers and preconditions specific for individual technologies used in biology teaching, such as mobile graphic data acquisition system, digital microscope, voting system. Such research could lead to the development of targeted advice how to efficiently increase the use of these technologies in biology teaching to support exploration, problem solving, cooperation, discussions, experimental activities by students, etc.

In terms of education of teachers, it would also be interesting to examine to what extent a lecturer's trust in digital technologies and experience with digital technologies use in the teaching of a particular subject is further transferred to a teacher–a course participant.

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