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Chapter

Educational Technology at the Study Program of Educational Physics at the University of Maribor in Slovenia

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Abstract

Physics is an experimental scientific discipline and needs to be introduced as such in schools. However, in recent decades, we witnessed intensive advancement in the field of computers, sensors, and measurement devices and also educational technologies, animations, and simulations, which one can use in teaching Physics. With ICT integration in education, we can supplement, but not substitute, different teaching methods, which include experiments. The modern teacher of Physics needs to be well trained in the use of all kinds of educational technologies, in particular in the field of experimental work. In this contribution, we analyze the study program of educational Physics at the University of Maribor in Slovenia, where we focus on achieving adequate competences for appropriate use of ICT in teaching theoretical topics as well as executing experiments.

Keywords: educational technology, experimental work, smart phone applications

1. Introduction

Information and communication technology (hereinafter referred to as ICT) is one of the most important and irreplaceable technologies of the twenty-first century. Among others, the rise of new technologies leads to important changes in the field of education. Educational systems in most EU countries [1, 2], including Slovenia, face a major problem of how to include the rapidly changing ICT field systematically and on a daily basis into teaching and learning. Consequently, in recent years, many studies of ICT integration [3–6] and its potential in the educational field were published.

ICT in education has a double role. Technology brings new tools that improve the teaching and learning process, but at the same time, ICT is a part of the curriculum with the goal of preparing students for life by providing them with all the necessary skills and knowledge. Note, that by word "student," we mean everyone who is studying at any educational level. We need to be aware that technology itself cannot be effective every time and does not necessarily improve students' knowledge. Teachers must have a good sense for planning when to include ICT, to what extent, and how to actively involve students. We must emphasize that science subjects require the development of experimental research skills and abilities, which cannot

be fully developed, or even replaced with even the most sensible inclusion of ICT. Experiments should not be substituted but supplemented by ICT tools. It is important that Physics teachers are digitally literate and well trained in the use of all kinds of educational technologies, particularly in the field of experimental skills. In our opinion, only a smart combination of educational technologies can improve the understanding of students. Furthermore, it can lead to the development of not only digital and science competences but also entrepreneurship competences. The EntreComp study [7] defines entrepreneurship as a transversal key competence that act upon opportunities and transform ideas into value for others.

In our contribution, we use qualitative research methods based on a documentary research method and experience-based analysis. We analyze the study program of educational Physics at the University of Maribor in Slovenia with a focus on achieving adequate competences for appropriate ICT integration in teaching theoretical topics and experimental work.

2. Information and communications technology

New technologies based on ICT are appearing in different areas. In the field of education, ICT ignites important changes. Availability of ICT is an indicator showing the progress and development of a society. ICT literacy has become one of the most significant life skills or competences and has been influencing many areas in life. An individual wanting to function in society in a socially acceptable manner must, therefore, be digitally literate. Gerlič et al. [8] claims that a digitally competent individual using ICT is more successful, creative, and innovative, handles valid and reliable data, and is aware of legal and ethical principles of safe and responsible use of technology.

Digital literacy can be defined as the ability to use digital environments to acquire important knowledge. A digitally literate individual can:

- recognize IT needs;
- effectively acquire necessary data;
- be critical to information and sources;
- incorporate gathered data into its own skill set;
- use the information to achieve set goals; and
- follow ethical rules and legal regulations regarding acquiring and use of information [9].

ICT development is extremely fast, and the field is constantly changing and upgrading. At first, ICT applies only to hardware, but today it also covers applications (software), networks (Internet), and services. One of the most important ICT resources recently is mobile technology (smartphones, tablet PCs, handheld devices, etc.), which has developed rapidly over the past decade. Its significance has been increasing mostly due to mobility. With the help of the Internet, the user can communicate and quickly access various content and information at any time. ICT has become accessible and available immediately and almost everywhere. This in itself offers not only many advantages but also disadvantages, which is seen as excessive stress and abuse of information technology.

A large variety of things that people used to do by thinking, technology does for them today. Spitzer [10] warns about the phenomenon of the so-called digital dementia—the sneaking of mental abilities due to the use of digital technology. For children, Spitzer even recommends all schools should ban all forms of digital technology. However, this is highly unlikely. We should not abandon digital technology as it does serve several educational benefits. Instead, we need to learn how to use it responsibly to get the best out of technology and look after the mental health of both the younger generation and ourselves. As Tearle [11] concludes, although ICT requires additional work for a teacher, it enables positive learning outcomes.

3. Incorporating ICT in the educational process

Educational systems in most EU countries, including Slovenia, are facing a major challenge of how to include the rapidly changing ICT field systematically into teaching and learning. Because changes in education occur gradually and introducing new approaches is relatively slow, there is a discrepancy between general use of ICT in everyday life and its use in education [1, 12].

By incorporating ICT in education, one can notice improvement of the teaching and learning process. Furthermore, as ICT is a part of the curriculum, students gain skills and knowledge that are important also in everyday life [13]. In addition, ICT can be a tool to develop other key competences. In order to utilize all ICT advantages, we need to familiarize students with the basic skills to work with ICT, starting with the early years of study. Content should be included in school subjects in the most suitable manner allowing for the use of technology. Therefore, word processing should be included in mother language and spreadsheets in mathematics when learning about functions or data presentation. We believe regular inclusion of current technology in the teaching process would accustom students to the practical use of technology.

The updated curricula in Slovenia recommend the use of ICT in the educational process. ICT is used in class by teachers according to their personal preferences, which depends on their skills and attitude toward technology. Therefore, for the development of digital competences of students, it is relevant that teachers possess sufficient skills and competences to incorporate ICT in their teaching practices on a daily basis.

Gerlič [8] gives five main advantages of the use of ICT in the learning process, as follows:

- increased motivation of students (ICT provides interactive and multimedia lessons which draw students' attention);
- easier and improved access to information (teachers can prepare materials and tools in advance and students can access them using computers and the Internet);
- support of modern teaching approaches (problem lessons, teamwork lessons, and cooperative learning);
- greater teacher efficiency (ICT helps teachers access various sources to form lesson plans).
- improved information literacy (ICT helps improve teacher and student information literacy).

ICT gives students many positive changes that influence their motivation and activity during lessons. We need to be aware that technology cannot be effective every time and does not necessarily improve students' knowledge. Sensible use of technology requires a lot of knowledge and preparation. Teachers must have a good sense for planning, when, how, and why include ICT and to what extent. In addition, teachers must have skills in the didactically reasonable use of ICT during lessons [14, 15]. Science subjects require the development of experimental research skills and abilities (observing, classifying, developing experimental techniques, comparison, etc.), which cannot be fully developed or even replaced with even the most sensible inclusion of ICT. Therefore, just using ICT in the classroom does not automatically mean an increased contribution of ICT to the lesson and the students' knowledge.

4. ICT deployment in Slovenian schools

In Slovenia, the systematic ICT deployment in education started in 1994 with the project called RO—Computer Literacy. The program was designed to encourage schools to increase the number of computers, hardware, and software equipment, and thus affect the motivation of the lessons. The implementation of this project took place during the years from 1994 until 2000. With the introduction of ICT, curricula, textbooks, and didactic materials were updated. In addition, it was crucial to educate teachers. Initially, teachers attended general introductory seminars in order to update with technology, which was later used in a variety of administrative matters and lesson planning. Later, they began not only to educate teachers in the use of ICT in these areas but also in their individual subject areas.

The Ministry of Education, Science and Sport assured one of the major breakthroughs of the system from 2006, based on the upgraded Action plan for the follow-up leap of the IT implementation in schools. With the resources of The European Social Fund, The Ministry of Education and Sport carried out a variety of public tenders and direct projects in public institutions (National Education Institute Slovenia and ARNES) under the name of e-education.

Within the "e-education," educational consultancy support and technical assistance to schools were developed and implemented, as well as the development and implementation of the standard called "e-competent teacher and principal". The proposal of the standard called "e-competent teacher," which contains six fundamental e-competences, was not formally introduced [16].

The six fundamental e-competences are as follows:

1. Knowledge of and ability to critically use the ICT.

2. The ability of communication and cooperation at a distance (teachers, educators, and other educational professionals, parents, and students).

3. The ability to search, collect, process, and evaluate (critical assessment) data, information, and concepts.

4. Safe use and compliance with the legal and ethical principles of information use and information publication.

5. Designing, creating, updating, and posting products (materials).

6. The ability to design, implement, and evaluate teaching and learning with the use of ICT.

In addition to the aforementioned project "e-education," a few other projects in the field of ICT deployment were carried out between 2007 and 2013 with co-financing from the European Social Fund: e-competences for teachers in bilingual schools; Production of multimedia and interactive e-learning materials; e-books; a project called e-schoolbag; and a project called IR optics.

After all these projects, it was found that the use of ICT in the classroom in Slovenian schools is in accordance with the average use of ICT in classrooms of EU countries [1, 2]. Slovene teachers participated in several trainings regarding the use of ICT, which were beyond the development phase of the "basic training." Now, most of the training is in the area of pedagogical use of ICT.

In January 2016, the Ministry of Education, Science and Sport adopted Strategic guidelines for further implementation of ICT in the Slovenian education until 2020 [17]. This document presents current initiatives and policies in Slovenia and the European Union. In addition, it defines the vision of providing an open, creative, and sustainable learning environment supported by innovative use of ICT. The aim of ICT integration is to improve the effectiveness and quality of obtained knowledge and skills of key competences that one needs for successful integration into society.

Other objectives are to provide a higher level of utilization of ICT skills within the whole educational system and thereby contribute to the development of key competences. The latter also includes participants in the adult education and thereby represents the provision of comprehensive development of the competences of educators, teachers, coordinators, principals, and teachers in higher education (formal education and further training) with effective forms of training. This leads to the strengthening of the professional community, with the active exchange of good practices, or through mutual learning and providing quality services (counseling, assistance). This should also be pursued through the provision of various forms of training (seminars, workshops, consultancy, etc.) of educators, teachers, higher education faculty, and professional staff and principals for better and more efficient education with the support of ICT.

In addition to ICT deployment and developing digital literacy, the Ministry of Education, Science and Sport run the project called "Strengthening the competence of entrepreneurship and promoting a flexible transition between education and the environment in gymnasiums," which started in 2018 and will finish in 2022. The main objectives of the project are to establish, implement, and evaluate the model to develop entrepreneurship competences among students. The latter can be achieved by introducing flexible forms of learning, cross-curricular connections, student-centered learning, authentic problem solving, and innovative use of ICT.

5. The use of ICT in education

The use of ICT in the educational process can be divided into three major areas. The primary scope encompasses activities through which learners become familiar with the operation and use of ICT (general educational area—ICT literacy), or they upgrade their knowledge or decide about a vocational route (specific professional education area). The secondary area encompasses the ICT integration in the educational process itself. In this case, ICT acts as a teaching resource or device in a variety of learning activities, which are linked to the direct educational process in the individual subjects. It can take part in all or only in certain stages of the learning process, such as introductory stage, processing new learning contents, practice exercises, revision, knowledge testing, and decision-making on the workflow. The tertiary area covers activities that accompany the educational process: business and

technical-organizational elements characteristic of the educational system (administration, organization, information, and communication). Nowadays, the use of ICT in this area is indispensable. The information system of education that allows internal, local, national, and transnational networking through ICT is becoming an increasingly important factor in the development of the tertiary area.

The critical review of ICT integration in education is done by Livingstone [18], who presents both obstacles and challenges that schools face, and improvements in learning outcomes.

5.1 e-learning

ICT has brought new opportunities for the acquisition and creation of knowledge. It has become a vital element of the modern processes of education. In general, the term e-learning refers to the possibility or the use of ICT in education [19]. Gerlič et al. [8] cites three different approaches of the use of ICT in learning and teaching. The first approach, a classic or traditional education, takes place in the classroom. The teacher uses technology as mere interpretation assistance to achieve greater student motivation. Students use classical textbooks, workbooks, and e-materials. The second approach, e-education, is carried out with the help of ICT in synchronous or asynchronous form. Synchronous learning means that communication between participants takes place at the same time. This allows two-way communication between teachers and students (audio-video conferencing, chat rooms, the Internet, or classical telephony, etc.). In the case of asynchronous forms, the educational process is delayed, participants are not logged on to the network at the same time, and their communication takes place time independently (e-mail, Internet forum, e-materials, etc.). The third approach represents a combination of the above forms of teaching (blended learning). This means that the concepts of learning and teaching are characterized by different styles of learning or teaching methods and using physical and virtual learning media, through which a diverse range of learning outcomes and educational didactic effects are achieved.

Finally, the so-called m-learning or mobile learning has occurred. It refers to the use of more advanced, mobile technologies [20, 21]. m-learning is part of e-learning, and the essential difference between them is in mobility. This type of technology is accessible in every step of the way and allows us to communicate with other users, logging onto the World Wide Web, it enables the use of a wide range of services and applications, and is, at the same time, is easy to use [22].

5.2 ICT teacher

The use of ICT in the educational process has its own advantages [23, 24]. Nevertheless, the quality of the lessons still depends primarily on the teacher, who forms learning objectives, content, forms of work, etc. The classic role of the teacher as the transmitter of knowledge is diminishing, while the role of the teacher as a facilitator, who directs and encourages the acquisition of new knowledge, is increasing. The teacher's guiding of information, obtained by a student with the help of ICT, improves quality of knowledge and helps students to create a holistic image of the world and themselves. At the same time, it represents the foundation for learning and education development.

When using ICT, it is crucial that teachers are critical to the devices they use. They need to use ICT intelligently and in particular in accordance with the educational objectives and the modern pedagogical principles. Use of ICT increases teacher productivity and saves time mainly for the following:

- daily lesson planning and updating,
- adapting to individual student's needs,
- presentation of learning content,
- the creation and maintenance of the evaluation,
- the creation of a wide variety of exam questions, and
- keeping reports, records, and archives with the possibility of rapid data acquisitions and additions.

Furthermore, teachers examining different ways of incorporating ICT in the education process in order to increase the effectiveness of their work are also developing their entrepreneurship competences.

The use of ICT during the teaching process is closely related to the teachers' self-assessment of their own ICT competences, their assessment of the suitability of ICT use, and to the accessibility of ICT in an individual school. The more teachers feel confident about their ICT skills and competences, the more they are willing to undergo further training in the field and to incorporate ICT-related activities in their teaching at all levels of education. A survey from 2011, Condition and Trends in the Use of ICT in Education, shows that teachers' problems due to lack of experience on the application of ICT occur less often than the European average. At the same time, however, teachers believe that they are poorly trained to deal with ICT and need additional professional education. The computer is mostly used in class by younger teachers; the frequency of use declines with the growing age of a teacher [25–27].

Jimoyiannis and Komis [28] disclose that teachers recognize positive educational benefits of the use of ICT, especially from the science teacher's respective. On the other hand, they also highlight problems regarding ICT integration in education in terms of effectiveness and organization.

Gerlič believes it is particularly necessary to motivate and properly train teachers and not only to provide adequate software and hardware. Future teachers should be properly trained for the meaningful use of ICT in education during their studies. The latter is also studied by Drent and Meelissen [29]. They point out that a lack of ICT competence among teachers can often represent an obstacle. In their study, they conclude that the innovative use of ICT demands personal entrepreneurship competences. In addition, the innovative use of ICT enhances the learning process of students and affects the development of entrepreneurship competences among students themselves.

5.3 Guidelines for using ICT in Physics lessons

In the ICT deployment in Slovenian schools, the curriculum of individual subjects had been changed and supplemented. Therefore, in up-to-date curricula, it is recommended the implementation of ICT in the pedagogical process. The Physics curriculum in Slovenia allows great opportunities for meaningful inclusion of ICT in class.

The curriculum refers to reasonable use of the World Wide Web and computer-based measurement with interfaces and sensors. A computer with an interface and a set of sensors should become a measurement system for data acquisition and processing and a tool for analyzing and presenting measurements. Computer

simulations and animations could be a useful complement to Physics lessons, especially when the nature of the phenomenon is such that it cannot be shown by an appropriate experiment. Teaching can be enhanced using a computer classroom and appropriate software, selection of e-materials, animations, and access to the World Wide Web.

Curricula also point out that the use of information technology can only complement experimentation rather than to substitute it. Computer simulation does not achieve the motivational or didactic effect of a well-demonstrated experiment.

The curriculum does not restrict the way ICT is used but encourages it. Thus, ICT can be used in lessons in many ways:

- electronic answering machines can be used to check and evaluate knowledge (Student Response System Socrative, Clicker, Plickers, Microsoft Interactive Classroom, Turning Point, Google Drive, Moodle, etc.)

- web classrooms can be used to track work done, collect students' materials, check knowledge, collaborate work, etc. (Moodle, Google Classroom, etc.) and

- use of e-materials in combination with doing a worksheet when adopting a new subject matter (e-textbooks., sio.si, e-va.e-um.eu, nauk.si, etc.)

In the field of Physics, there are many examples of the use of ICT in teaching in the Slovene language, as well as some sets of e-materials that cover curriculum content, but we must consider the fact that they were created at different times and that the curricula had already changed in the meantime. In the proceedings of the international conference Sirikt, which is the largest in our area in the field of the use of ICT in education in Slovenia, there are many examples of the use of ICT in teaching Physics. There is also a lot of contributions published in the magazine Physics at School.

By examining the meaningful use of ICT in the classroom, we cannot ignore a collection of manuals published by the public institution of The National Education Institute of Slovenia: Modernization of lessons in High School practice—PHYSICS, mechanics, heat, oscillation (Part 1); Updates of lessons in Elementary School practice—PHYSICS and Challenges of developing and evaluating knowledge in High School practice—PHYSICS, electricity and magnetism, wave, modern physics (Part 2).

5.4 Models in natural science teaching

Čepič emphasizes the importance of experimentation and demonstration when she interprets three various models of the description of a scientific phenomenon: the theoretical model, the computer model, and the experimental model. Of course, all the models mentioned concern the planned simplification and neglect of the various circumstances of the scientific phenomena examined in exchange for the possibility of organized methods of exploration and experimentation [30].

In the theoretical model, one describes natural events using abstract mathematical description that allows for quantitative predictions and hypothesis testing using measurements. Theoretical models are always used by students whenever their task is something to calculate. Using ICT, we can create a computer model with various simulations or animations of natural science phenomena. Thus, students acquiring some experience, associated with natural phenomena, do not observe this phenomenon directly. We must be aware that the computer model is the preprogramed flow of the test resulting from the theoretical model. The maximum value of computer

models is the point of view of the symbolic representation of phenomena that we cannot see and the possibility of integrating developments at the sub microscopic level. In experimental models using devices and tools, we can present complex natural phenomena in the classroom. Such model successfully develops skills and competences in experimental research. Students can do practical work by gaining practical experience in new areas while leading them to an understanding of complex phenomena of nature. Virtual experiments using ICT (computer, mobile device) are also considered to be part of an experiment in the broader view. The results of such experiments are predefined with the program itself and do not allow any experimental error in terms of improper implementation of the experiment, overlook the circumstances of the actual experiment, the imprecise measurement, and others.

The study conducted by Jimoyiannis and Komis [31] confirms the positive outcome of the use of ICT and computer simulation in physics class. Additionally, it shows that the use of ICT can improve students understanding of the examined topic of the trajectory motion.

It is important that simulations and animations do not replace experiments. Computer models should be applied rationally and especially as a complement to experiments. Students, who discover natural phenomena only through ICT, will never acquire experimental skills.

6. Study program of educational physics

We have determined that sensible and rational use of technology requires a lot of knowledge on the teacher's part. Besides mastering ICT, a teacher should be able to make sensible use of information technology during class.

The modern Physics teacher needs to be well trained in the use of all kinds of educational technologies, particularly in the field of experimental work. It is therefore important for students during their studies to achieve adequate competences for an appropriate use of ICT in teaching theoretical topics as well as in executing experiments.

According to Gerlič, it is of great relevance that study programs for teachers should include subjects and content covering the competences and skills listed below:

General ICT and Computer Sciences (regardless of their specialization, students must acquire basic knowledge and skills in ICT and Computer Sciences, in using information systems and the computer in class, as well as for school administration. Students of Science, Mathematics, Craft, and Technologies also need basic skills in the field of designing simple educational software; they need an in-depth insight into computer networks, the multimedia, conference systems, distance learning, etc.).

Specific competences for the use of a computer in the field of their specific subject (students are familiarized with the use of the computer and information systems in the field of their specific subject).

Specialized didactics competences (within the course of specialized didactics, students of any subject specialization are familiarized with the possibilities of ICT use in their chosen subject field) [32].

We analyzed the study program of educational physics at the University of Maribor in Slovenia. The study program Physics teacher follows the principles of the Bologna process and includes modern study content, various organizational approaches, and modern work methods, which ensure greater connectivity between theory and practice. This means that during their studies, students have more practical training and they start with it sooner, which ensures a better integration of

students in the school environment and gives them a better insight into what they will have to do after finishing their studies at the university.

6.1 Subjects in the field of ICT

The student of the Physics teacher program has several subjects with ICT content [33]. Information and Communications Technology and The Computer in Physics are taught in the first year. Both are core subjects. Students acquire knowledge in the theoretical and practical field of use of ICT in education and the profession. Students can work independently and creatively to solve practical problems in education and studies and can use computer tools to process and display the results of measurements. Working with a computer is particularly important for all lab work and writing physical texts.

Among the subjects that are optional, some subjects develop competences in the ICT field in depth. In the fourth year, students can choose the subject e-education and information technology in Physics and in the fifth year, e-learning and Computer-aided Laboratory Work.

Given the rapid development of ICT technology, it may be better if those subjects would not be of the optional type.

In ICT-based subjects, students can develop some of the entrepreneurship competences, for example as defined by EntreComp [7] mobilizing resources and mobilizing others. They also get acquainted with ICT tools that can enhance motivation and the active role of students.

6.2 Subjects in the field of physical experiments

Because Science subjects require the development of experimental research skills and abilities, let us now look in which subjects' students of the Physics Teacher Program acquire the necessary competences for experimental work.

Subjects are spread across the entire study path. In the first year of the study, students have Physical Experiments 1, in the second year Physical Experiments 2, in the third year Physics Experiments 3 and Physical Experiments 4, and in fourth year Physical Measurements.

Students in these subjects refresh and extend their knowledge obtained from attending lectures, especially topics that are essential for the successful and correct execution of laboratory work. Students also acquire experience and laboratory skills that are essential for autonomous execution of demonstrative physics experiments. They learn how to use their theoretical and practical knowledge, as well as information offered from secondary sources to master problems that might occur during experimental work and report on their findings.

In the subject Physical experiments 1, students take laboratory work with topics from mechanics. Experiments are in the following topics: Kinematics, Dynamics, Hydrostatics, and Hydrodynamics [34].

In the subject Physical experiments 2, students take laboratory work in thermodynamics and electromagnetism. Experiments are done in the following topics: Clausius-Clapeyron equation, Thermal expansion, Ideal gas equation, Specific heat of metals and liquids, Heat of fusion, and Heat of vaporization [35].

In the subject Physical experiments 3, students take laboratory work in oscillations and waves and in wave and geometrical optics. Experiments are done in the following topics: Undamped and damped oscillations, forced oscillations and resonance, Electrical oscillation circuit, Traveling and standing waves, Lenses and mirrors, Systems of lenses, Diffraction and interference, Spectroscopy, and Blackbody radiation [36].

In the subject Physical Experiments, four students take laboratory work in the field of Modern Physics. Experiments are done in the following topics: Experiments with Roentgen rays, Experiments with microwaves, Franck-Hertz experiment, Photo-effect, Measurement of the Planck constant, Gaussian distribution, Measurement of the ideal gain of a heat engine, Diffusion of liquids, Magnetic resonance spectroscopy, Gamma ray spectroscopy, Michelson interferometer, Diffraction of beta rays in an electromagnetic field, and Absorption of beta and gamma rays [37].

In the subject Measurements in Physics, students acquire basic theoretical and practical knowledge in the field of measurements. Among the contents are the following topics: Description of the measurement of the scalar and vector quantities, Tensors and transfer function, feedback to the system, thermic noise. Basic electrical circuits, Measurement of the constant quantity, statistics, tests, least squares method, Respond of the system to the periodical disturbance, Measurement of the time and frequency, feedback loop, and standards, Sensors of displacement, and Temperature sensors [38].

Within described subjects, students develop entrepreneurship competences, which are reflected in creativity, valuing ideas, mobilizing resources, taking initiative and planning, and management skills. The development of entrepreneurship competences can be supported by the way experimental laboratory work is carried out. For example, instead of executing an experimental work step by step in accordance with instructions, we could only present to students what we want for them to measure or which information they have to obtain by experiment.

6.3 Subjects in the field of didactics

Students of the Physics teacher program learn about the possibilities of using a computer in the classroom with specific didactics subjects. The following didactics subject matter is linked indirectly to the study program on ICT and experimental work: Didactics of physics 1 with practicum; Didactics of physics 2 with practicum; Pedagogical practice for teaching physics 1; Pedagogical practice for teaching physics 2.

The objectives of these subjects are the acquisition of teaching experience in the development of Physics teacher skills and technology. In addition to the first experiences with lessons planning, students also learn about the possibilities of using ICT in the classroom and deepen their knowledge in the field of physical experimentation at school. Students develop skills of safe design, execution of experimental exercises, and competence in writing and verbal expression to the professional and lay audiences. They are able to prepare the self-developed practice exercise in a manner, which is suitable for its inclusion in the teaching of physics. They are skilled to execute measurements in various physical fields of school Physics and to use the computer with interface and sensors within these measurements.

Having thoroughly reviewed the study program, we can conclude that the young Physics teacher acquires enough knowledge to use ICT in class, especially in the field of experimental work. It goes without saying, however, that the educational program cannot provide all the competences needed by a young teacher for practical work. Certain competences can only be acquired through experience and additional training.

7. Conclusions

In Slovenia, several projects in the field of ICT were implemented at the national level [16, 17]. Upon the completion of all these projects, it was found that [2] the

use of ICT in the classroom in Slovenian schools is in accordance with the average use of ICT in classrooms of EU countries. In the final report of the survey of ICT in education prepared for the European Commission [12], Slovenia ranks among top countries regarding the percentage of students that are in digitally supportive schools, and have high access to ICT and high-speed Internet. Furthermore, the study indicates that Slovenia has the highest percentage of students that are taught by digitally supportive teachers. One of the main obstacles in some countries is insufficient ICT equipment [3, 6], which, regarding this study, cannot be true for Slovenia.

Several studies confirm [4, 24] that integration of ICT in education brings new opportunities and tools that improve the teaching and learning process. As Livingstone [18] points out, ICT enables mobilization of resources, collaborative learning, and can improve motivation and learning outcomes. The abilities of mobilization of resources and collaborative learning are in the EntreComp framework [7] two of entrepreneurship competences.

Besides mastering ICT, a teacher should be able to make sensible use of information technology in class. Education in the field of training Slovene teachers for the use of ICT was beyond the development phase of "basic training." Nevertheless, Gerlič [32] addressed shortcomings regarding some training programs of teachers which do not include contents of information and computer science. Nowadays, most training programs focus on the area of didactic use of ICT [8, 13].

The updated curricula in Slovenia recommend the use of ICT in the educational process. Teachers use ICT in teaching at their own discretion, depending on their knowledge and attitude to technology [14, 15, 24–26]. Sang et al. [27] shows that ICT integration in education correlates with teacher attitudes and beliefs, which is confirmed by the study of Jimoyiannis and Komis [28]. The Physics curriculum allows many opportunities for a meaningful integration of ICT into teaching [30, 31].

The modern Physics teacher needs to be well trained in the use of all kinds of educational technologies and ICT, particularly in the field of experimental work. It is therefore important for students, during their studies, to achieve adequate competences for appropriate use of ICT in teaching theoretical topics as well as in executing experiments. These competences are digital competence, mathematical competence, and basic competences in science and technology. In addition, we think during studies, students can work on various activities that lead to the development of entrepreneurship competences. One of such activities could be an innovative and smart use of ICT that results in increasing the time efficiency and improving learning outcomes at the same time. Furthermore, ICT provides development of other entrepreneurship competences such as mobilizing resources and others, financial and economic literacy, planning and management, working with others, and learning through experience.

Based on the study program review [33–38], we can conclude that the young Physics teachers acquire enough knowledge to use ICT in class and to do experimental work. Students have several mandatory subjects with ICT content, in which they acquire knowledge in the theoretical and practical field of ICT use in education and the teaching profession. In specialized didactics subjects, students learn about the different possibilities of the pedagogical use of ICT in class.

Because Science is primarily concerned with the development of experimental and research skills, students have many subjects in this field across the entire study course. In these subjects, students refresh and extend their knowledge obtained from attending lectures and also acquire experience and laboratory skills that are essential for autonomous execution of demonstrative physics experiments.

Of course, the educational program cannot provide all competences needed in practice by a young teacher. Certain competences can only be acquired by experience and additional training. The fact is that the teacher will have to regularly acquire new competences in the rapidly changing ICT field by consistently undergoing additional training. In this contribution, we present one example that is m-learning. With the rapid development of mobile technology over the past decade, most students have smartphones, but they use them more or less exclusively for entertainment. Despite the fact that smartphones are powerful devices, students do not consider using them for educational purpose. With a multitude of built-in sensors, a smartphone can easily become a measuring device for physics experiments. The teacher should be able to take advantage of all the potential that these devices possess in the educational process. In most schools, the use of smartphones is prohibited. In our opinion, the attitude toward the use of smartphones will have to change over time, if we want students to be prepared for life and use these devices sensibly.

Regardless of all the positive outcomes, we must be aware that excessive use of technology also brings negative consequences that are reflected in addiction, excessive stress, and abuse of information technology. But the fact remains that digital technology offers many benefits in education. We need to learn how to use it responsibly so that we can get the best out of technology and look after the mental health of both, the younger generation and ourselves.

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Conflict of interest

The authors declare no conflict of interest.

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References

[1] Pelgrum WJ. Obstacles to the integration of ICT in education: Results from a worldwide educational assessment. Computers & Education. 2001;**37**:163-178. DOI: 10.1016/S0360-1315(01)00045-8

[2] Wastiau P, Blamire R, Kearney C, Quittre V, Van de Gaer E, Monseur C. The use of ICT in education: A survey of schools in Europe. European Journal of Education. 2013;**48**(1):11-27. DOI: 10.1111/ejed.12020

[3] Becker HJ. Access to classroom computers. Communications of the ACM. 2000;**43**(6):24-25

[4] Cooper B, Brna P. Supporting high quality interaction and motivation in the classroom using ICT: The social and emotional learning and engagement in the NIMIS project. Education, Communication and Information. 2002;**2**:113-138

[5] Godfrey C. Computers in school: Changing technologies. Australian Educational Computing. 2001;**16**(2):14-17

[6] Ertmer PA. Addressing first- and second-order barriers to change: Strategies for technology integration. Educational Technology Research and Development. 1999;**47**(4):47-61

[7] Bacigalupo M, Kampylis P, Punie Y, Van den Brande G. EntreComp: The Entrepreneurship Competence Framework. Luxembourg: Publication Office of the European Union; EUR 27939 EN;; 2016. DOI: 10.2791/593884

[8] Gerlič I, Krašna M, Pesek I. Information and Communication Technologies in Slovenian Elementary Schools: Situation and Prospects. Maribor: Faculty of Natural Sciences and Mathematics; 2013 Informacijsko komunikacijske tehnologije v slovenskih osnovnih šolah: stanje in možnosti. Maribor: Fakulteta za naravoslovje in matematiko; 2013. (in Slovene)

[9] Stopar K, Kotar M, Pejova Z, Knap N. Criteria and Indicators of Information Literacy in Higher Education. Ljubljana: Association of Librarians' Societies of Slovenia; 2010. Merila in kazalci informacijske pismenosti v visokem šolstvu. Ljubljana: Zveza bibliotekarskih društev Slovenije; 2010. (in Slovene)

[10] Spitzer M. Digital Dementia: How We Make Our Children and Ourselves Out of Mind. Ljubljana: Mohorjeva Založba; 2017 (Digitalna demenca: kako spravljamo sebe in svoje otroke ob pamet. Ljubljana: Mohorjeva založba; 2017. in Slovene)

[11] Tearle P. A theoretical and instrumental framework for implementing change in ICT in education. Cambridge Journal of Education. 2004;**34**(3):331-351. DOI: 10.1080/0305764042000289956

[12] Survey of Schools: ICT in Education. [Internet]. 2013. Available from: https://ec.europa.eu/digital-single-market/sites/digital-agenda/files/KK-31-13-401-EN-N.pdf [Accessed: 22 December 2018]

[13] Brečko BN, Vehovar V. Information and Communication Technology in Teaching and Learning in Slovenian Schools. Ljubljana: Pedagogical Institute; 2008. Informacijsko-komunikacijska tehnologija pri poučevanju in učenju v slovenskih šolah. Ljubljana: Pedagoški inštitut; 2008. (in Slovene)

[14] Higgins S, Moseley D. Teachers' thinking about information and communications technology and learning: Beliefs and outcomes. Teacher Development. 2001;**5**(2):191-210

[15] Hermans R, Tondeur J, Braak J, Valcke M. The impact of primary school teachers' educational beliefs on the classroom use of computers. Computers and Education. 2008;**51**(4):1499-1509

[16] Kreuh N, editor. Bilten e-šolstvo: Pot do e-kompetentnosti. Ljubljana: Miška; 2012. 28 p. (The way to e-competence). (in Slovene)

[17] Strateške usmeritve nadaljnjega uvajanja IKT v slovenske VIZ do leta 2020 (Strategic guidelines for the further introduction of ICT in the Slovenian schools by 2020). [Internet]. 2016. Available from: http://www.mizs.gov.si/fileadmin/mizs.gov.si/pageuploads/StrateskeUsmeritveNadaljnjegaUvajanjaIKT1_2016.pdf [Accessed: 21 December 2018]

[18] Livingstone S. Critical reflections on the benefits of ICT in education. Oxford Review of Education. 2012;**38**(1):9-24. DOI: 10.1080/03054985.2011.577938

[19] Welsh ET, Wanberg CR, Brown KG, Simmering MJ. e-learning: Emerging uses, empirical results and future directions. International Journal of Training and Development. 2003;**7**:245-258. DOI: 10.1046/j.1360-3736.2003.00184.x

[20] Korucu AT, Alkan A. Differences between m-learning (mobile learning) and e-learning, basic terminology and usage of m-learning in education. Procedia Social and Behavioral Sciences. 2011;**15**:1925-1930. DOI: 10.1016/j.sbspro.2011.04.029

[21] Ally M, Prieto-Blazquez J. What is the future of mobile learning in education? Mobile Learning Applications in Higher Education [Special Section]. RUSC. 2014;**11**(1):142-151. DOI: 10.7238/rusc.v11i1.2033

[22] Zalar K. Primeri uporabe in primernost mobilnih naprav za izobraževanje (Examples of use and mobile devices educational suitability). [Internet]. 2016. Available from: http://pefprints.pef.uni-lj.si/1132/1/Diploma_Ksenija_Zalar.pdf [Accessed: 24 December 2018]. (in Slovene)

[23] Zhang D, Zhao JL, Zhou L, Nunamaker JF. Can e-learning replace classroom learning? Communications of the ACM. 2004;**47**(5):74-79

[24] Valtonen T, Kukkonen J, Kontkanen S, Sormunen K, Dillon P, Sointu E. The impact of authentic learning experiences with ICT on pre-service teachers' intentions to use ICT for teaching and learning. Computers & Education. 2014:1-24. DOI: 10.1016/j.compedu.2014.09.008

[25] Akbaba S, Kurubacak G. Teachers' attitudes towards technology. Computers in the Social Studies. 1999;**7**(2):833-836

[26] Myers JM, Halpin R. Teachers' attitudes and use of multimedia technology in the classroom: Constructivist-based professional development training for school districts. Journal of Computing in Teacher Education. 2002;**18**(4): 133-140

[27] Guoyuan S, Martin V, Braak J, Tondeur J. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. Computers & Education. 2010;**54**:103-112. DOI: 10.1016/j.compedu.2009.07.010

[28] Jimoyiannis A, Komis V. Examining teachers' beliefs about ICT in education: Implications of a teacher preparation programme. Teacher Development. 2007;**11**(2):149-173

[29] Drent M, Meelissen M. Which factors obstruct or stimulate teacher educators to use ICT innovatively? Computers & Education.

2008;**51**:187-199. DOI: 10.1016/j.compedu.2007.05.001

[30] Čepič M. Modeli v poučevanju naravoslovja. In: Moravec B, editor. Posodobitve pouka v osnovnošolski praksi. Ljubljana: Zavod RS za šolstvo; 2014. Models in science teaching. In:Moravec B, editor. Updates of teaching in elementary practice: Ljubljana: Institute of education of the Republic of Slovenia; 2014. p. 31-37. (in Slovene)

[31] Jimoyiannis A, Komis V. Computer simulations in physics teaching and learning: A case study on students' understanding of trajectory motion. Computers & Education. 2001;**36**:183-204

[32] Gerlič I. Organizacija: Uporaba Informacijske in Komunikacijske Tehnologije v Slovenskih šolah. (Organization: Use of Information and Communication Technology in Slovenian Schools). 2005;**8**:383-385 (in Slovene)

[33] Subject Teacher: IZO FIZ—curriculum 2018-2019. [Internet]. 2018. Available from: https://www.fnm.um.si/index.php/2018/02/09/predmetni-ucitelj-izo-fiz-predmetnik-2018-2019/ [Accessed: 17 December 2018]

[34] Physics experiments 1. [Internet]. 2018. Available from: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2018-2019/EMAG_IZO-FIZ_Fizikalni_eksperimenti_1.pdf [Accessed: 17 December 2018]

[35] Physics experiments 2. [Internet]. 2018. Available from: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2018-2019/EMAG_IZO-FIZ_Fizikalni_eksperimenti_2.pdf [Accessed: 17 December 2018]

[36] Physics experiments 3. [Internet]. 2018. Available from: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2018-2019/EMAG_IZO-FIZ_Fizikalni_eksperimenti_3.pdf [Accessed: 17 December 2018]

[37] Physics experiments 4. [Internet]. 2018. Available from: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2018-2019/EMAG_IZO-FIZ_Fizikalni_eksperimenti_4.pdf [Accessed: 17 December 2018]

[38] Measurements in Physics. [Internet]. 2018. Available from: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2018-2019/EMAG_IZO-FIZ_Fizikalna_merjenja.pdf [Accessed: 17 December 2018]