

Information and Communication Technology in Education - Current Trends

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Abstract. The paper is aimed at current approaches toward using of information and communication technology in education. Firstly, nowadays usage of computers in education is introduced on the basis of an overview and survey of the researches presented on the recent conference Computers in Education organized by the Asia-Pacific Society for Computers in Education. Last research in the following areas is discussed here: computer-supported personalized and collaborative learning, seamless learning, level of attention and learning efficiency, learning analytics, application of innovative educational technologies in STEM education, and online game-based learning in school education. Despite the geographical orientation many issues may be inspirational for scholars from western countries. On the other hand, from research papers presented by researchers from Asia-Pacific region it is evident that they have been focusing on very similar topics in education as scientists in western countries do. Secondly, some observation concerning usage of information and communication technology in Egypt education as well as recent research works examined within the doctoral study program information and communication technology in Education provided by the University of Hradec Králové, Czech Republic, are presented in the paper in the light of the mentioned survey.

1 Introduction

The Department of Informatics of the Faculty of Science at the University of Hradec Králové (UHK) provides doctoral study program of ICT in Education (guaranteed by the first author of the paper) in cooperation with the Faculty of Education at the UHK and others three Czech Faculties of Education. This unique study program, recognized as the only one in the Czech Republic, is focused on preparation of experts in the major of information and communication technologies in education. Furthermore, it is also concentrated on their independent creative work in the field of science, research and their good prerequisite for further development of the area of information and communication technology (ICT) in Education.

Graduates of pre-gradual studies will expand their knowledge of detailed content and methods of main areas of informatics. They will particularly increase understanding of theoretical basis of aforementioned science field. They also acquire more in-depth knowledge of new trends in pedagogical and psychological subjects. ICT in Education is a very new and extremely fast developing area. In this field, it is necessary to explore and develop qualitatively different attitudes that have their roots in scientifically validated theories based on results of many foreign researches.

Thanks to the fact that one of our doctoral students, the second author of the paper, had chance to spent

several months in China and during the stay took part at the 23rd International Conference on Computers in Education (ICCE 2015) held in Hangzhou last December, we had an opportunity to collect findings presented at the conference.

The aim of the paper is to introduce this conference search in the line with the latest Czech doctoral research works dealing with ICT usage in education as well as with observation concerning the mentioned area in Egypt education presented in works of the third author.

1.1 Conference on Computers in Education

The conference was organized by the Asia-Pacific Society for Computers in Education (APSCE). This society was established in 1989 and organizes conferences related to the aforementioned topic every year. Since the first year of establishing of APSCE the conferences have become a major event and great opportunity for researchers and scholars from all over the world to connect with each other and to develop and deploy ideas that span the field of Computers in education.

This time more than 163 papers from 24 countries related to use of information and technology for education were accepted. Most of them were presented by researchers from Asia-Pacific region, mostly from Japan, Taiwan, China and Thailand. The West part of the

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world was represented by 17 papers. Despite the geographical orientation many researchers from Asia-Pacific region have been focusing on very similar topics in education as scientists in western countries do.

In spite of the wide variety of papers some similar topics attracted researcher's attention. Those issues were mentioned in many papers; therefore we may introduce them briefly in section 2.

2 Current Trends within ICT in Education

2.1 Computer-supported personalized and collaborative learning

The importance of computer-supported personalized and collaborative learning was a highly discussed topic. Regarding this field some research papers were based on identifying the effects and impacts of flipped classrooms on pupils and student's achievements in different areas. Flipped classroom is described as an innovative and effective approach which engages students in a lesson and learning process actively and also changes the role of teacher. A teacher is considered to be more a guide or coach than that the one who is providing all-knowing to students and they only passively listen to.

Teachers often create videos and use websites, tutorials and new technologies to enhance problem-solving ability, discussion, cooperation and interaction among students. Students watch the video before the class and use the class time to solve complex concepts, answer question and students are encouraged to learn actively [1].

Using this new approach for teaching means that a teacher should handle new challenges of this creative and interactive way of education. Some research raised a question whether this method is equally efficient for students of different ages (younger people, middle age people and old age people). The results showed that the effectiveness of the method was influenced by will and personal preferences of participants. Nevertheless, all groups reached better results in learning.

The second research *The Role of Social Presence in a Flipped Classroom to Facilitate Oral Skills of Language Learners* [2] also confirmed positive effects of flipped learning. The results revealed that the combination of online learning community and flipped learning not only supported social and interpersonal communication and collaboration but also enhanced the participants' oral proficiency. This approach made the participants more competent and motivated in interactive learning activities (online or in-class interaction, collaboration and discussion).

Possibilities how to enhance collaboration and cooperation were mentioned many times. Some of other researches using computer-supported and collaborative learning (CSCL) have scrutinized impact of this method on promoting of interaction, collaboration, help each other, motivation and interests in learning. For example, *Study of GS-Based "Factor" Collaborative Learning in a*

Primary School [3] proved positive effects of CSCL in aforementioned aspects.

2.2 Seamless learning

Many researches were driven with the idea to uncover opportunities of support of seamless learning. This is an approach in which learners can create relationships between their formal and informal learning. To support seamless learning, some seamless learning systems have been proposed, as for example aforementioned method flipped classrooms which tries also to incorporate and use this principle. Some researchers describe seamless learning system as a system based on the learners' textbooks (teaching materials) which can be prepared as e-Book. Learners can record their learning in class and the system allows them to link up what they have learned in class and what they have experienced outside of the class by providing quizzes or book information. One of such works devoted to this topic was *e-Book Based on Seamless Learning System*. [4]

2.3 Level of attention and learning efficiency

Other groups of research works were based on exploring the field of level of attention and learning efficiency. These works often used the comparison between traditional and digital learning materials. One of the goals of these works was to understand how different types of teaching materials affect learners' attention and how particular materials can unfold their potentials faster than others. The preliminary experiment described in the paper *A Study of Attention Difference between Traditional and Digital learning Materials Using Brainwave Measuring Devices*, showed that the attention level was higher when studying digital materials compared to traditional printed materials. [5] Electroencephalography (EEG) was used for collecting data that were analysed later and they showed significant differences in brainwaves while working with different types of materials.

Very similar results were shown in the other pilot experiment *The Effect of a Mobile Mathematical Game on the Mathematic Learning of the Student with Intellectual Disability* [6]. Intellectual deficit is often manifested by lowered ability of concentration, short-term memory and other cognitive skills. It means that many areas needed for efficient learning are impaired and acquiring of new information is very demanding for learning and also teaching. A digital game used as a tool for learning had positive impact on participant's learning gains, he was able not only to learn a new concept in mathematics but this fact positively influenced his self-esteem and confidence for next learning. To sum up, it may change the personal attitude of someone with disabilities towards education.

Although many research and preliminary experiments have had positive results and often confirmed their positive hypothesis, it is worth mentioning researches those results were opposite and so provoking critical thinking and new questions for those who would be otherwise too optimistic or uncritical positive towards

new technologies and computer-supported learning. One of the research with different outcomes is following.

The Comparison of students' perceptions of small group discussion in online and face-to-face environments [7] was targeted on understanding of students' experience in online and face-to-face discussion. The researchers compared their perceptions towards these two environments in five aspects: learning, affection, reading and writing skills, critical thinking skills and efficacy. Although online tools have been often accepted by many as mainstream of collaborative learning during recent years, this research has showed that the students having the opportunity to choose between these types of discussion still prefer to participate in face-to face interaction.

2.4 Learning analytics

Digital data was an issue that has been discussed very often. On the one hand it is becoming very powerful and its good analysing can bring new opportunities in education. However, on the other hand, we must be aware of its dark side. Not only researchers but also teachers at all levels of schooling find the topic of learning analytics very important and potentially extremely beneficial for teachers and their students to unfold their potentials. Regarding to this issue let us mention the research and project about Lea's Box, *A Competency-oriented Approach to Facilitate Learning Analytics in School Settings* [8]. Lea's Box is a research and a development project funded by the European Commission. The project has focused on the fact that school-based teaching and learning are producing the digital data but tools for analytics of the data (which can lead to enhancing and individualizing of teaching process) are still missing. This new tool enables teachers not only to collect but also to analyse and visualise educational data of their pupils. Thanks using this technology, a teacher can tailor education for each student more specifically and make better and more suitable decisions about their pupils. The goal is to evaluate individual achievements and competencies and provide the learners with the best possible individual support and teaching. Besides the schools from Austria some schools from the Czech Republic and Turkey also participated in this project.

2.5 Application of innovative educational technologies in STEM education

Next area which was filled with wide numbers of research was application of innovative educational technologies in STEM (Science, Technology, Engineering, and Mathematics) education. STEM education is vital for nation's competitiveness in the global economy. Therefore, STEM has been recognized as a part of education which should be changed in order to become more effective.

Both of the following research stressed the need of increasing mathematical critical-thinking. Moreover, the authors of the first research consider mathematical thinking as a skill necessary for the 21st century skills.

The first research related to STEM, *Non Numerical Aspects of School Mathematics* [9], claims that shifting the focus from numeracy (acquiring of basic mathematical ability) to consideration of mathematics as much wider cognitive ability is necessary.

Intended learning may fail to be achieved for many reasons and if the purpose of the mathematical tasks is confined or limited to 'solving', rather than 'learning from solving', it is likely that learners may neither learn nor enjoy engaging with the problem.

The authors underpin that the core of enhancing mathematical thinking is conscious questioning where the numbers do not have to be used. Students need to apprehend vocabulary, definitions and implement/shift aspects of a problem situation into understanding, solving and then connecting new knowledge into their mental concepts. Deeper questioning is the means for students can make sense of mathematics and digital tools should be effectively used to promote student questioning.

The second research, *Integration of Reciprocal Teaching-ICT Model To Improve Students' Mathematics Critical Thinking Ability* [10], is focused on integrating ICT with reciprocal teaching. Reciprocal teaching use four strategies to increase and maintain good engagement of students in learning process- These four strategies are:

1. summarizing what they read and identifying the main idea,
2. inquiring in order to ensure they understand the material,
3. clarifying parts of the text that may be confusing,
4. predicting what text they may or should read as a following step.

Students in the experimental class where reciprocal teaching- method and ICT were used reached better scores in all indicators (thinking, questioning, connecting, evaluating). The students had a lot of chance to ask questions, develop the problem that made them think more critical and were more active comparing with the control group.

Both two aforementioned researches concluded independently that for better acquiring mathematical skills and mathematical thinking a non-number concept – questioning is irreplaceable.

2.6 Online game-based learning in school education

In the last part of this article we would like to introduce the topic of constructivist online game-based learning in school education which gained attention of many participants at the conference.

The research Implementation of Mario-like Digital Game in Chemistry Education: Results on Students' Perception [11] presents the effectiveness of a digital game which was used for enhancing student knowledge in chemistry. Researchers observed influence and impact of digital game on six related areas: perceived learning, perceive ease of use, flow, playfulness, enjoyment and perceived satisfaction. The instruction is based on Bloom's taxonomy that presents pedagogical and psychological background and could motivate students'

learning. „Mario like“ is a digital game which has four levels of playing corresponding with four dimensions of Bloom taxonomy – Remember, Understand, Apply, Analyse.

The findings of the research showed successful improving in all observed areas and revealed positive impact of using digital game-based learning in education.

The next research which is worth mentioning, also using game-based learning as the previous research is *The Development of a Game-Based Formative Assessment Mathematical Algebra Tutorial App* [12]. In addition, the researchers included mobile learning and formative assessment. The principal goal of this study is to explore effects of formative assessment strategy on the learning effectiveness of a student. One of the conclusions for the game-based formative assessment mathematical algebra tutorial app is adoption and development of the mechanism of feedback and scoring. There is necessary to find balance and accurate ratio between teaching and game playing. It means to avoid more attention on game playing than on the teaching contents. The research concentrates not only to deepen the basic knowledge of mathematics, but also to promote learners' ability of analysis and answering questions.

3 Current Trends within ICT in Egypt education

In this section let us present issues that have attracted attention of the second author and his colleagues from Egypt in recent years, see [13], [14].

3.1 Artificial intelligence in education (AI-ED)

The main goal of this multidisciplinary field of study AI-ED is to develop intelligent software which is capable to model human mind and thanks to it can be very beneficial in educational process. This development of knowledge-based software which can be used in real education (teaching, leaning and skill training) is the vital point of many research that have been carried out in one of the main seven areas which are namely: Intelligent Educational Systems (IES), Teaching Aspects, Learning Aspects, Cognitive Science, Knowledge Structure, Intelligent Tools, Shells and Interfaces.

Different intelligent learning applications have been already developed in order to improve students' skills and to enable them faster enquiring of knowledge about complex problems. For instance, such learning applications are URI, CANCER or Heart. These tools are cases-based intelligent learning systems for diagnoses of particular diseases. The last mentioned intelligent learning application provides not only description of symptoms, but also treatments proven successful in similar cases and possible alternative causes of the pain are explained.

One of the main domain of artificial intelligence in education, to which gradually more research pay attention, is to create computer systems that can be used as collaboration tools and can enable to acquire new knowledge and skills in very effective way. The issue of

motivation strengthening is also crucial topic for Artificial Intelligence. In addition, many researches in this area have been dealt with the issue of providing of assessment of learning outcomes. It is evident that artificial intelligence and its new paradigm and approaches such as case-based reasoning and intelligent data mining aiming to support individualized needs of learners and have been also recognized as an important aspect in e-learning technologies.

3.2 Intelligent Tutoring Systems (ITS)

Using Artificial Intelligence concepts and new forms of educational software can allow the computer to act as an intelligent tutor. Intelligent tutoring system (ITS) can adjust its tutorial to the student's knowledge, experience, to minimize their weaknesses and boost their strengths.

ITS has been focusing on acquiring and building knowledge with a new approach called case-based reasoning (CBR). CBR means reasoning which has its origins in own experiences or in solving strategies of previous cases or problems. Research outcomes underpin the natural way of learning by fact that students learn best when they are presented with examples of problem-solving knowledge and are then required to apply the knowledge into real situations. This case-based reasoning is the opposite attitude to so called rule-based reasoning which represents a learning style when required knowledge has been already described by "knowledge experts" and learners' own experience is not needed. In this type of reasoning learners are asked to use most of all their memory and recall the rules or facts that did learn previously. Whereas the case-based reasoning provides realistic problem-solving situations, presents them to the students as virtual simulations and so enhances students' thinking.

Intelligent tutoring system also allows flexibility in teaching methods, achieving many of the same benefits as one-on-one instruction. Moreover, ITS and case-based reasoning approach enable to compose lessons with different levels of knowledge by following the school curriculum. The system can recognize learner's knowledge level from previous results and can choose and adapt difficulty of lesson that fits to student's actual knowledge. Additionally, ITS enhances productivity and allows to cope individually with bigger number of students than one teacher can cope.

3.3 Data mining Technology in Education

For most of Artificial Intelligence areas it is crucial to collect data, extract information from data set and transform it into an understandable structure for further use. Therefore the field of data mining technology and techniques seems to be indispensable because of its compounding of artificial intelligence, database system and statistics. There are many technics of collecting and analyzing data such as: clustering, regression models, classification, summarization, link analysis, sequence analysis, sequential pattern mining (SPM), text mining and association rules mining (ARM). This field of data

mining is beneficial for e-learning educational methods. Moreover, a good adjusted e-learning system can contribute to effective solving of some acute problems in educational field. In countries when the number of learners is increasing and there is lack of educational institutions and lack of qualified teachers eLearning presents a chance for involving more students in higher education and prevent them from dropping out of the educational system early.

4 Doctoral study program ICT in Education

With regard to above-mentioned issues we can emphasize that the research topics realised within the doctoral study program ICT in Education closely correspond with them. Let us introduce some of actual research topics conducted within our doctoral study program:

There are the following main areas on which we have concentrated:

1. Mobile technology Applied in Education (e.g. [15])
2. Technology Enhanced Natural Science Teaching and Learning (e.g. [16])
3. Technology Enhanced Foreign Language Teaching and Learning (e.g. [17])
4. Programming techniques (e.g. [18])
5. Social and cultural impact of modern communications for education (e.g. [19])

To give better insight into works of our students, let us introduce abstracts of dissertation works defended in the last two academic years.

Interactive web applications as means towards increasing the efficiency of chemistry instruction [20]

The Internet and its web interface have brought new possibilities into chemistry instruction. Learning computer models (LCM) seem to be an efficient means towards increasing the clearness and stimulation of pupils' cognitive activity but their applications within the process of instruction have not been researched to a large extent in the Czech Republic. That is why this dissertation project focuses on LCMs of acid-base titrations. In the dissertation thesis we dealt with types of questions what and under what conditions the pupil can learn being supported by LCM of acid-base titration. We supposed the LCM could make the process of acquiring the learning content easier on all knowledge levels which were operated in chemistry (symbolic – microscopic – macroscopic level) as well as they could be a relevant means for introducing learning situations where the activity and responsibility for learning were turned over the pupil.

E-learning in Foreign Language Teaching at Universities [21]

The dissertation describes research focused on the implementation of information and communication technologies (ICT) in learning and teaching English for Specific Purposes (ESP) at universities. Its theoretical part deals with an analysis of the current situation in education, concentrating on the elements of this complex

system and on the influence of technologies on the educational system. Based on the conclusions of the theoretical part, a practical design for the implementation of technologies that support the active role of students of foreign languages was created with the aim of strengthening their motivation for learning by applying a cooperative form of work. The empirical research was conducted in the form of a case study that validates the proposed learning activities supported by Web tools in education and provides the information which helps us understand the processes occurring within this specific form of learning. The aim of this work is to enrich the e-learning of foreign languages with the use of currently available Web tools in tasks simulating activities students are apt to encounter after university and to contribute to the development of theoretical knowledge in the field of methodology and ICT in education.

Prevention of Software Piracy of Primary School Pupils and Secondary School Students [22]

The dissertation is focused on infringing copyright by primary school pupils and secondary school students. The dissertation brings the answer to the question whether sufficient knowledge of main legal aspects related to software, musical work and films affects behaviour and attitude of pupils and students to software, music and film piracy. The theoretical part of this work explains some basic terms related to the mentioned issue. It gives information about the current legislation concerning copyright infringement in the Czech Republic, EU, the USA and in the international law. It provides evaluation of the current state of the issue being solved in available information sources, curricular documents and in preventive activities of ministries and non-governmental organizations.

The practical part of this work includes a pilot study, definition of the research problem and specification of research questions and hypotheses. It presents the course of the pilot study and main study as well as their results and conclusions. The data are analysed in the following part of the work and the relation between knowledge of pupils and students and their attitude to the software piracy is studied. Based on the research results and the relation analysis that prove the urgency and seriousness of the research issue, preventive and corrective measures are presented. These measures are in the form of a suggestion concerning the scope of curriculum and expected outputs of school educational programmes with a view to get basic knowledge of the legal aspects connected with the software, music and film piracy. The proposed scope of curriculum was proved by experimental teaching.

Possibilities of Language Skills Development within the Framework of Communicative Competence Mastering in E-learning Language Courses [23]

The dissertation focuses on the difficult issues connected with implementing techniques for testing used by foreign language teaching methodology to practice and reinforce receptive language skills in reading and listening comprehension. Furthermore, the paper is also focused on

productive writing skills in e-learning language courses using a basic variety of technological exercises. The purpose of the research was to determine the effect on the practice of the aforementioned language skills when applying different pairs of testing techniques with various types of technological exercises within the process of the implementation. The analysis of pre-tests, progress tests, post-tests and feedback questionnaires proved that some pairs are more suitable for practicing and strengthening of language skills than other pairs. A description of the most suitable pairs provided at the end of the dissertation may be a significant contribution for authors of e-learning language courses as a convenient guide in the preparation of learning materials.

The influence of educational system applications for measurement using a computer on the popularity of physics at the elementary school [24]

The dissertation focuses on the impact of educational system applications for measurement using computers in a school science lab on popularity of physics at the elementary school. The theoretical part describes systems for measurement using a computer and an own system called SMPS as configurable alternatives to commercial products. It introduces the didactic and technological aspects of scientific experiments with the help of systems for measurement using a computer.

5 Conclusion

In the paper we presented an overview of today's research connecting to topic ICT in Education. To sum up, increasing number of professionals have recently become to be aware that the use of technology in education has had a significant impact on early childhood learning. However, the early childhood education including the use of ICT has not been largely explored research area so far. There is a growing expectation that preschool teachers and researchers will find the integration of theories and practices and will be able to recognize effective tools and implement them into the early childhood education. In the paper *The role of kindergarten teacher in using technology in mathematic teaching classroom [25]* was clearly revealed that the teacher represents a key role for integrating of technology.

Teacher provides appropriate tool at the right time for children to explore and extend their play to a meaningful learning. Technology did not interfere children's learning but accelerate and narrow the achievement gap between low-income children and other affluent peers.

Acknowledgements

This research has been supported by Specific research project of the University of Hradec Kralove, both Faculty of Science and Faculty of Education in 2016.

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