DEVELOPMENT OF THE RESEARCH TOOL TO IDENTIFY FACTORS AFFECTING THE USE OF CHEMISTRY EDUCATIONAL SOFTWARE

Kateřina Chroustová, Martin Bílek
University of Hradec Králové, Hradec Králové, Czech Republic
E-mail: katerina.chroustova@uhk.cz, martin.bilek@uhk.cz

Andrej Šorgo
University of Maribor, Maribor, Slovenia
E-mail: andrej.sorgo@um.si

Abstract

Currently, the implementation of information and communication technologies (ICT) has been strongly recommended to science teachers. For identification the factors of successful ICT implementation the Unified Theory of Use and Acceptance of Technology (UTAUT) is applied, which works as the theoretical background of planned monitoring of Czech chemistry teachers´ attitudes to this problem. This theoretical review introduces the process of creating the modified UTAUT model serving as the basis for a research tool to be exploited for the future survey. Within this process three sources were exploited: (1) theories dealing with factors which influence user behaviour in relation to the use of modern technologies, (2) the analysis of research results focused on the acceptance and use of ICT in chemistry instruction and (3) results of researches conducted by the authors in the field of the effectiveness of the educational software used in chemistry teaching and learning. The conducted analysis of these three sources resulted in defining the presented survey and designing the appropriate theoretical model and research tool.
Key words: *chemistry education, educational software, The Unified Theory of Use and Acceptance of Technology (UTAUT), teachers´ attitudes.*

Introduction

Within the last decades, numerous resources had been attributed towards the implementation of hardware components and peripherals into schools, following with the use and adaptation of primarily non-educational software and development of educational software and teaching multimedia materials. However, this potential cannot be fully developed if teachers do not accept educational software as an educational tool and a source providing learning content and do not use it. The rejection has two rationales; the first one is the acceptance and use of ICT in education in general, and the second one is the use of particular pieces of hardware and software. A number of researches has been accomplished, both on the acceptance of ICT in general, (e.g. Martinovic, Zhang, 2012; Valtonen, Kukkonen, Kontkanen, Sormunen, Dillon, & Sointu, 2015), or on the acceptance of specific technologies, e.g. tablets (Ifenthaler, Schweinbenz, 2013), interactive whiteboards (Tosuntaş, Karadağ, Orhan, 2015) and different educational software (Šorgo, Verčkovnik & Kocijančič, 2010). To determine factors affecting the use and acceptance of educational software by all the actors of the educational process is an integral part of the search for reasons, whether and, if so, when and why is the use of this software in chemistry as the general-education subject beneficial.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 68, 2015

Considering the fact that in the Czech Republic there has been a lack of researches on the acceptance and use of educational software in specific educational context, we started our research activities. The main objective of our research is to create a model of factors affecting the acceptance and the use of educational software by learners and teachers of chemistry as the general-education subject. The theoretical background of the proposed model includes:

1) Eight theories related to The Unified Theory of Use and Acceptance of Technology, including personal traits and characteristics such as gender, age, experience in the use of educational software and ICT etc.

2) Results of analyses of other researches (e.g. Donnelly, McGarr, O'Reilly, 2011; Prestridge, 2012; Hernández-Ramos, Martínez-Abad, Peñalvo, García, & Rodríguez-Conde, 2014).

3) Results of our own researches.

Eight Theories Relating to the Unified Theory of Use and Acceptance of Technology (UTAUT)

The Unified Theory of Use and Acceptance of Technology (UTAUT) was designed by Venkatesh, Morris, Davis, & Davis (2003). It was built on a combination of the eight earlier theories on the acceptance and motivation for the usage of technology with the purpose to create a unified theory. This theory resulted from following theories: Theory of Reasoned Action (TRA), Technology Acceptance model (TAM), Motivational Model (MM), Theory of Planned Behaviour (TPM), Combined Theory of Planned Behaviour/Technology Acceptance Model (C-TPB-TAM), Model of Personal Computer Use (MPCU), Diffusion of Innovations Theory (IDT), and Social Cognitive Theory (SCT). The UTAUT theory identifies four basic determinants of behavioural intention towards the acceptance of information technology: performance expectancy (i.e. the degree of persuasion that use of the system helps users achieve improvement of job performance), effort expectancy (i.e. the degree of simplicity associated with the use of the system), social influence (i.e. the degree of persuasion that people that are important for the users believe that he or she should use this new system) and facilitating conditions (i.e. the degree of persuasion of the user that there is an organizational and technical infrastructure to support the use of the system) that are influenced by gender, age, experience, and voluntariness of use. We intend to apply the UTAUT theory to carry out the research survey focused on the description and interpretation of factors influencing the acceptance and use of educational software by teachers and learners in education of chemistry as a general-education subject based on its modification and adaptation to the current conditions of the Czech educational system.

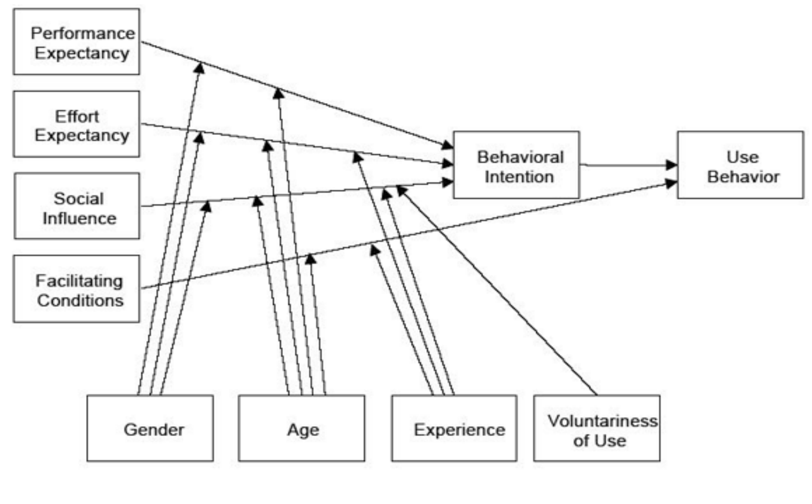

Figure 1: The Unified Theory of Use and Acceptance of Technology model. (Venkatesh, Morris, Davis, G. B., & Davis, F. D., 2003)

The UTAUT theory was formulated on the basis of the eight known theories affecting the motivation and reasons of our behaviour, environmental influences and surroundings on the acceptance of the new technology or on the speed of innovation diffusion (in this case on the diffusion of the new technology) among the population. It was necessary to study the foundations to create a research tools based on this theory.

Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) was created by social psychologist Ajzen and Fishbein in 1975 and 1980 (Fishbein, & Ajzen, 1975; Chang, 1998). This theory states that it is possible to predict "Behaviour of individual" (B) on the basis of "Behavioural Intention" (BI) which is influenced by two factors: "Attitude toward act or behaviour" (A) and "Subjective Norm" (SN). The attitude includes feelings of favourableness or unfavourableness towards this behaviour. The Subjective Norm includes individuals´ persuasion of whether it is expected from them to act in a certain way, or not. This theory has been applied to many different types of behaviour, including the acceptance of new technologies and become the basis for the Technology Acceptance Model (Oye, Iahad, & Rahim, 2014). Reflecting this, Ajzen defined the Theory of Planned Behaviour (see below).

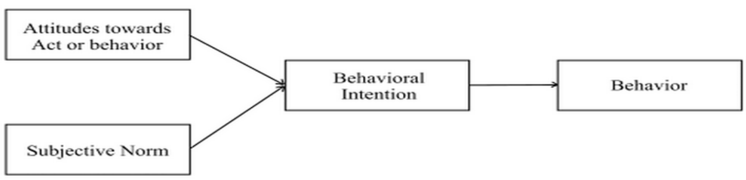

Figure 2: Theory of Reasoned Action model (Fishbein & Ajzen, 1975).

Technology Acceptance Model (TAM)

As mentioned above, the Technology Acceptance Model (TAM) is based on the above described Theory of Reasoned Action (TRA). The TAM was designed by Davis (1986), who also collaborated with Bagozzi, and Warshaw (1989). It intends to explain and predict the behaviour of users with regard to information technology: whether they accept and use the ICT. Other factors influencing attitudes to using IT were the perceived usefulness of the system and perceived ease of use; the perceived ease of use affects the perception of the usefulness for the individual. These two factors are also affected by external factors, such as e.g. systemic properties or characteristics of the user.

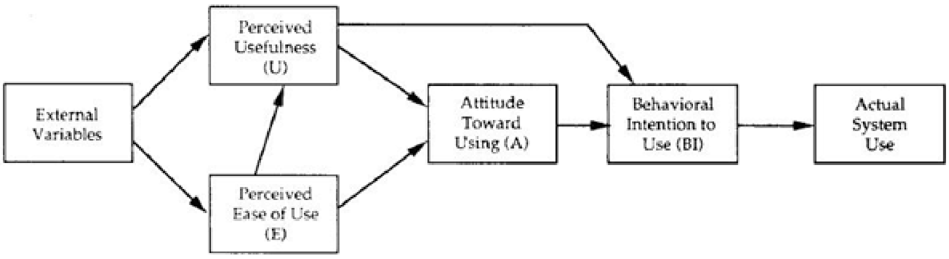

Figure 3: Technology Acceptance Model (Davis, Bagozzi, & Warshaw, 1989).

Motivational Model (MM)

After processing the TAM model, the same authors (Davis, Bagozzi, & Warshaw, 1992) have also started examining another factor influencing the computer use, respectively I(C)T in general – motivation. They proceed from theories that distinguish extrinsic and intrinsic motivation. The extrinsic motivation is defined as the supposition that users carry out their activity because they consider it to be a tool that leads to the achievement of valuable outcomes, such as promotion, salary etc. Then, the intrinsic motivation is expected to perform an activity without any other obvious fixation, but the performance of activity itself, i.e. they carry on the activity for its own sake than for any external reward. They asked the question whether users exploit the computer to work because they find it useful, i.e. to improve their job performance (extrinsic motivation), or because they enjoy its usage (intrinsic motivation). Within their research they proved the influence of both factors on the behavioural intention (Davis, Bagozzi, & Warshaw, 1992).

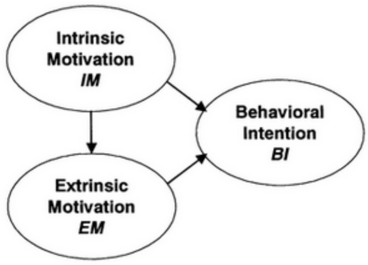

Figure 4: Motivational Model (Wilson, & Lankton, 2004).

Theory of Planned Behaviour (TPB)

Theory of Planned Behaviour (TPB) was designed by Ajzen, co-author of Theory of Reasoned Action (TRA), in 1991, as a follow-up one. It extends the factors influencing behaviour intention with the "Perceived behavioural control", which is related to a sense of the individual whether it is simple or difficult to him or her to behave in that way. It is also closely connected to self-efficacy and its definition by Bandura in 1977 and 1982. The theory also points out a partial impact the perceived behavioural control directly on the behaviour itself. Also reciprocal relationships are newly emphasized between these individual factors, i.e. between attitudes, subjective norms, and perceived behavioural control (Ajzen, 1991).

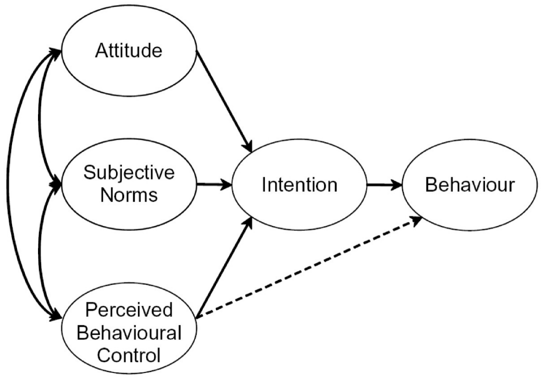

Figure 5: Theory of Planned Behaviour (Ajzen, 1991).

Combined Theory of Planned Behaviour/Technology Acceptance Model (C-TPB-TAM)

As it is evident from the name, this theory combines the Theory of Planned Behaviour (TPB) and the Technology Acceptance Model (TAM). It was created by Taylor and Todd in 1995. According to these authors, the TAM is useful for predicting the behaviour with regards to the usage of IT but the combined model provides a comprehensive understanding of the behaviour and behaviour intention (BI) considering the inclusion of the effects of normative and control beliefs of individuals. The authors assume that their model helps to better manage the process of IT implementation because it focuses on social influence and control factors in the system, which affect the use of IT (Taylor & Todd, 1995).

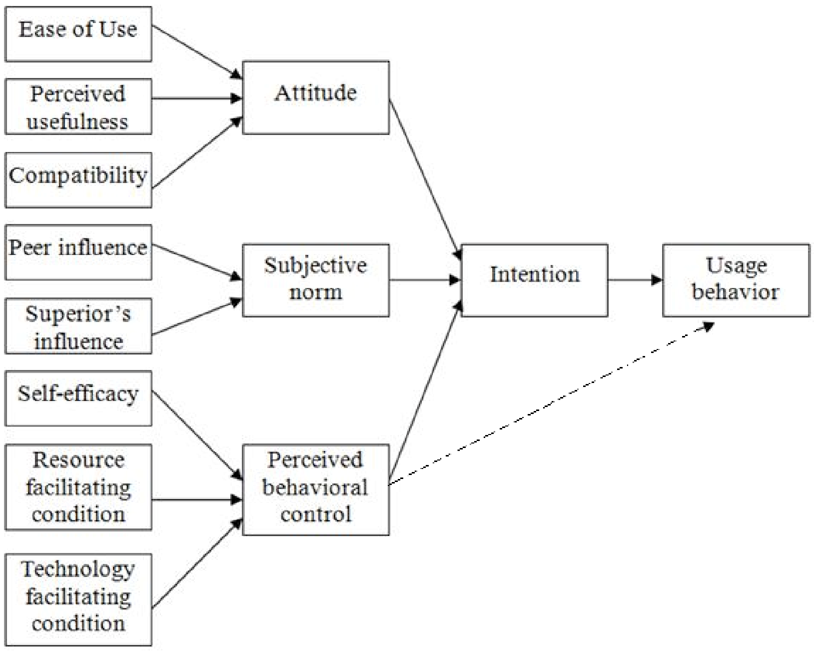

Figure 6: Combined Theory of Planned Behaviour/Technology Acceptance Model (Taylor, & Todd, 1995).

Model of Personal Computer Use (MPCU)

This model designed by Thompson, Higgins and Howell (1991) is based on the theory of behaviour created by Triandis in 1980. Unlike Fishbein and Ajzen (see TRA), the Triandis's theory distinguishes the persuasions relating to the emotions of the moment of action, or more precisely the behaviour from persuasions that are related to consequences, and indicates that the behaviour intention (BI) is influenced by the feelings towards this behaviour (affect), by what they think they should do (social factors), and by anticipated consequences of behaviour. The behaviour is then influenced by what people usually perform (habits), their behaviour intention (BI), and facilitated conditions (Thompson, Higgins, & Howell, 1991). Based on this theory, they created a model of factors influencing the use of personal computers (see Figure 7).

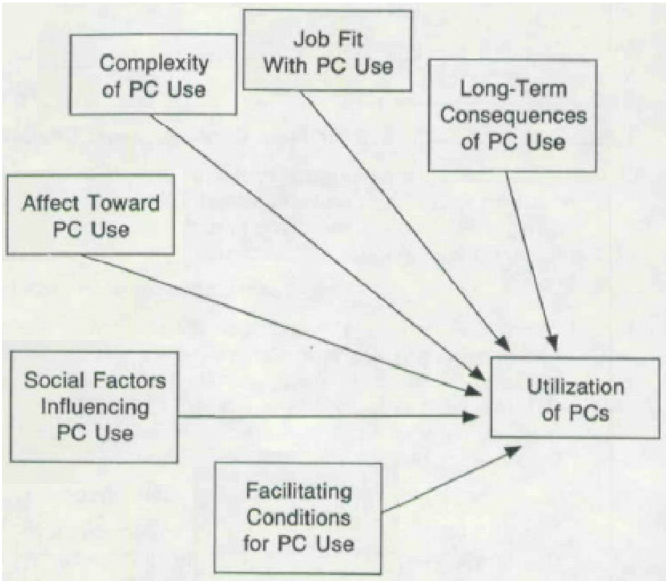

Figure 7: Model of Personal Computer Use (Thompson, Higgins, & Howell, 1991).

Diffusion of Innovations Theory (IDT)

This theory was created by E. M. Rogers in 1962 and describes the process and factors affecting the diffusion of innovation, which was defined as the process in which an innovation is given out through communication channels between individuals of the social system in time and space. This process consists of five stages: (1) knowledge (innovation gets into the consciousness of the individual, but he or she haven´t any further information about it), (2) persuasion (the individual gets active interest in the innovation), (3) decision (the individual is considering the advantages and disadvantages of the innovations and decides whether to accept or not this innovation), (4) implementation (acceptance of innovation and its use) and (5) confirmation (Rogers, 2003). There are many factors that affect how likely and how quickly people adopt innovation. According to Rogers, these factors include e.g. the relative advantage (innovation is better than the established standard), compatibility (compliance with moral values and norms of the social system), trial ability (users have the option to try out innovation beforehand) and observability (results of innovations can be observed in the surroundings; Rogers, 2003).

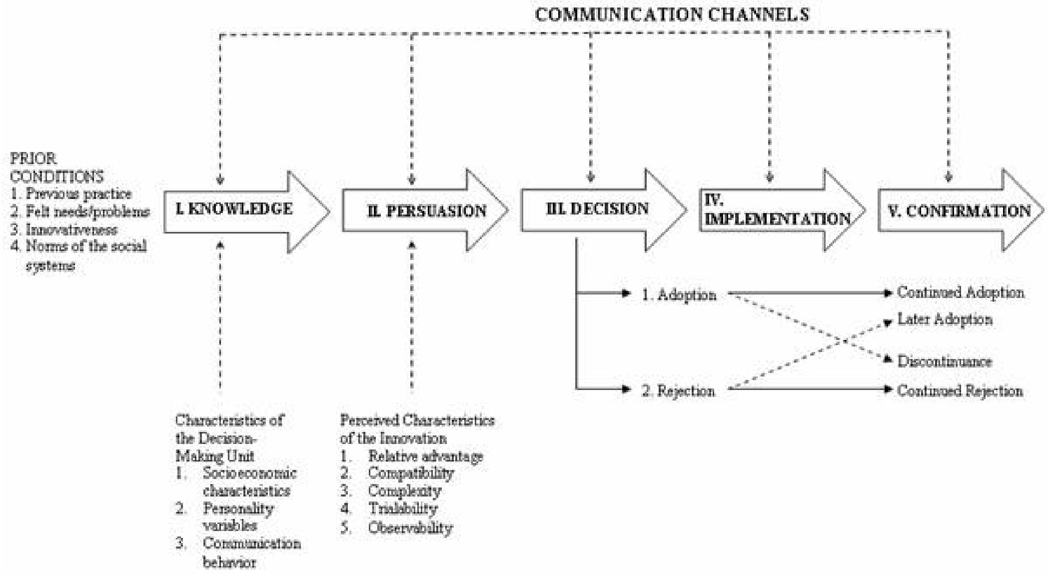

Figure 8: A model of Five Stages in the Innovation-Decision Process (Rogers, 2003).

Social Cognitive Theory (SCT)

The Social Cognitive Theory designed by A. Bandura is based on the interpretation of human behaviour from the model triadic reciprocal determinism which considers three groups of factors: behavioural (actions and decisions), as well as the personal factors (cognitive, emotional, physical factors, internal competencies) and environmental influences (e.g. the culture, laws and social context). The reciprocity consist in two-way interaction of factors and by determinism, i.e. the final effect of interrelated influences. This means that the behaviour itself interacts and influences the personal factors and environmental influences, it is not the product of this factors only (Bandura 1986; Bandura, 2001).

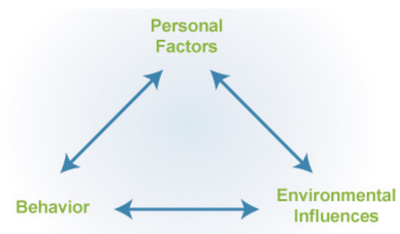

Figure 9: A Model of Triadic Reciprocal Determinism (Bandura, 1986).

From Researches Focused on the Exploitation of ICT in Science Education

The analysis of selected researches was the second source for the modification and adaptation of the UTAUT to the conditions of the Czech educational system in the field of science education, particularly in chemistry education. These researches were structured into three categories: the usage of particular educational software in various science subjects, the usage of alternative ICT tools in a real lab or real excursion and the usage of computer-based or computer-assisted instruction approaches in science education (Chroustova, Bilek, 2014a). We looked deeper at researches dealing with the influence of education software for chemistry education as the general-education subject and with an attitude of learners and teachers in their use. In selected databases (Web of Science, Scopus, EBSCO – SCI-INFO: scientific information sources for the Republic and Springer) we ran the search using keywords "educational software" plus "chemistry" within the time period of last 20 years, i.e. 1995–2015. The set of collected publications was subjected to critical reading of abstracts, and afterwards the remaining researches were examined with a focus on an exact description of the used methodology (Chroustova, Bilek, 2015).

Below, there are listed researches, providing major importance for the creation of our research tools based on the UTAUT.

The first research is the second data analysis of PISA 2006 in the Czech Republic (Kubiatko, & Vlckova, 2010), which discovered a positive relationship between the usage of ICT and knowledge of the natural sciences by 15-year learners where the ICT were used in the educational process, regardless of place of use i.e. at home, in the school or elsewhere. The results of the analysis suggest that ICT could fulfil a supportive role in reducing the difference between the achieved knowledge of the natural sciences among learners. These results show that ICT is a powerful tool for science education and therefore should be used more frequently and to a larger extent, and so we should deal with factors influencing the ICT implementation in the natural science/chemistry education.

Another research focused on the exploitation of ICT by teachers in innovative ways (Drent, & Meelissen, 2008) examined factors such as pedagogical approach, attitude to ICT and ICT competence, personal entrepreneurship, the perceived change and school factors. The results of this research show that teachers using ICT innovatively can be characterized by a specific combination of knowledge, skills, attitudes, and general competencies that determine their profile: (1) they are willing to keep extensive contacts with colleagues and experts in the field of ICT for their own professional development, (2) they understand and experience the benefits of innovative usage of ICT in their education, (3) their pedagogical approach can be described as oriented to the learners, (4) their ICT competence is in conformity with their pedagogical approach.

The research by Valtonen, Kukkonen, Kontkanen, Sormunen, Dillon, & Sointu (2015) examined how the experience of learning with the ICT support in pedagogically meaningful way may affect the attitude, subjective norm, self-efficacy and behaviour intention towards the use of ICT for teaching and learning of pre-service teachers with using the Theory of Planned Behaviour (TPB). The results of this research show that after the application of the e-learning course, statistically significant differences were detected in self-efficacy and in subjective norms related to the use of ICT for teaching and learning. However, there were no differences in attitudes and behaviour intention.

Another research by Voogt (2010) compared the factors influencing the so called extensive and the non-extensive use of ICT among teachers of natural sciences with regard to their educational orientation, their competence in the field of ICT and their professional engagement. This research showed a positive relationship between the frequency of the use of information and communication technologies and pedagogical orientation of teachers, their skills in ICT and their professional engagement.

The research by Efe (2011) focused on learners of science education and their attitudes towards education technology in the light of experience with its use, the intention to use it in their class, the efforts to provide opportunities to use ICT by learners and the belief in the value of educational technology for science education. A correlation was discovered between certain factors, e.g. learners with more experience in using educational technology had a greater intention to use it, they had a greater interest to enable their future learners to use these technologies in their classroom and they were more convinced of their value.

Previous Researches Accomplished by Our Own

The third source for the creation of our model are our own researches focusing on the comparison of the effectiveness of the educational software exploitation in different educational methods and organizational forms of chemistry education and on the optimization of the conditions for the application of educational software in a variety of educational methods and organizational forms.

The first research focused on the effectiveness of educational software in the final revision of inorganic nomenclature on the secondary chemistry education (Chroustova, Bilek, 2014b). In this research, we verified the hypothesis that learners ***achieved better results*** in chemistry lesson of traditional type (frontal education) where ***the educational software*** was used for the presentation of the learning content at the interactive whiteboard compared to identical frontal education of the same learning content where the educational software on interactive whiteboards was not used. The pedagogical experiment (see Figure 10) was conducted at the secondary school in lessons of chemistry as a general-education subject. The independent variable was exploitation of the education software called "Didakta – Chemie" at the interactive whiteboard. The dependent variable was the results achieved by learners in the test of knowledge. The pedagogical experiment followed the structure of pre-test – post-test – retention test (after six weeks).

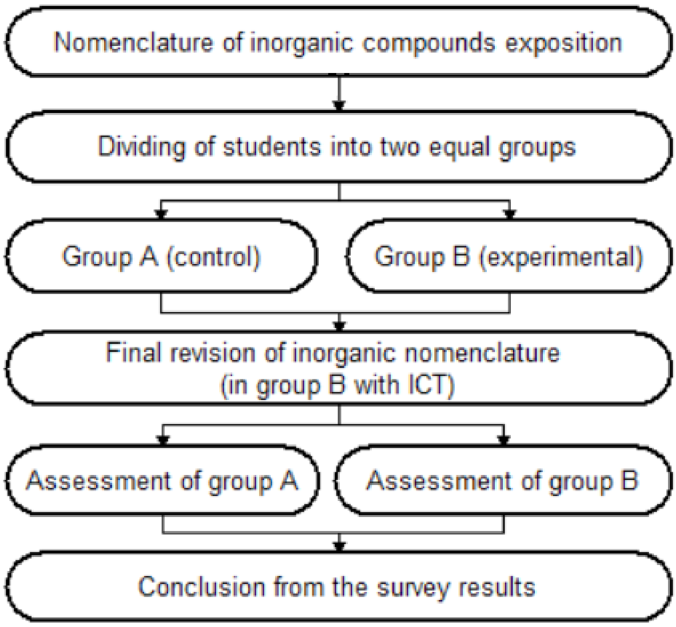

Figure 10: Course of the pedagogical experiment (Chroustova, Bilek, 2014b).

The results of pedagogical experiment (see Figure 11) show a higher rate in correct solving of algorithmic tasks by learners of the experimental group compared to the control group, but the positive effect (or more precisely significant difference) was not discovered to the total depth of learners´ knowledge when applying the educational software compared to the control group (in detail in Chroustova, Bilek, 2014b). The results of the post-test show that learners of the experimental group demonstrated the higher degree of acquiring the learning content immediately after its revision where the educational software "Didakta – Chemie" was used. In the retention test administered six weeks later the expected deterioration of learners' knowledge was discovered. If we compare the results of both groups, there is no statistically significant difference between them, which is why the longer retention of learners' knowledge after the general repetition with the use of educational software was detected. This fact points to missing the difference between learners who once revised the learning content applying the educational software, or did not. Therefore, we assume that regular use of educational software as a standard part of the lesson could have a stronger effect on fixing the learning content.

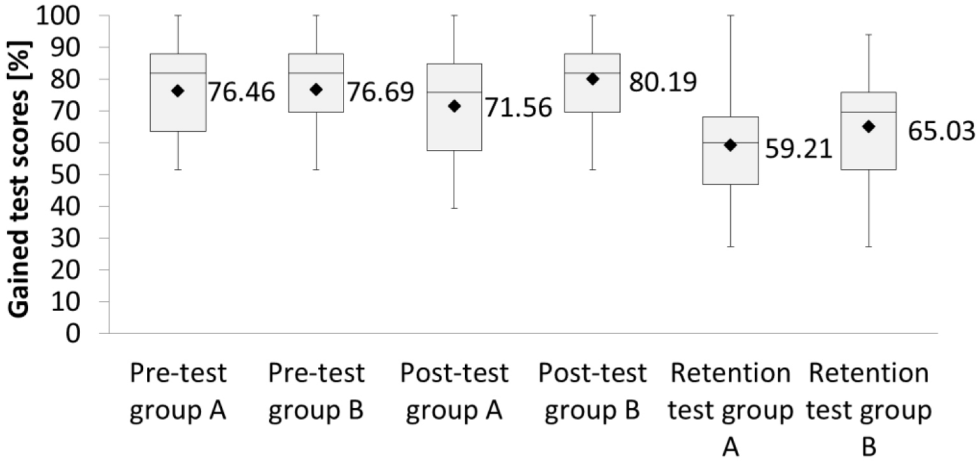

Figure 11: Results of didactic tests in the pedagogical experiment (Chroustova, Bilek, 2014b).

From the Means and Standard deviations (Figure 11) effect sizes (Cohen's d) were calculated, to present differences in knowledge gain. Between pre-test groups A and B difference (d = 0.02) is almost non-existent, what shows uniformity of both groups. Difference between post-tests of groups A and B falls close to the large effect (d = 0.49), and difference between retention tests of groups A and B is in medium effect (d = 0.285).

The second research focused on the evaluation of educational software (Chroustova, Bilek, 2014c). A comparative analysis of educational software for science education, particularly for chemistry education, in terms of its interactivity and its role in these multimedia educational materials was carried out. We used evaluation tool of LORI – Learning Object Review Instrument (v. 1.5) for evaluation of educational software. This tool includes all of the latest requirements for various types of educational software, including the international standards for metadata and usability for disabled learners (Belfer, Nesbit, Leacock, 2004). The results of our analysis show that the current educational software has different levels of interactivity. Usually they are interactive in the sense of response to program control and commands from the learner, but they are not interactive, or they are interactive to little extent only, in terms of real adaptation to the learners´ knowledge (the moderate extent of adaptation was demonstrated by e.g. the above mentioned educational software "Didakta – Chemie"). Generally, various types of educational software differ in the quality and fulfilment of the requirements of the LORI evaluation tool, depending mainly on their purpose. Thanks to the ICT development, the different types of educational software ordinarily include animation and visualization of high quality, but none of them provided tools to adjust the software to the needs of learners with sensory and motoric disabilities.

Creation of Research Model

From the above mentioned theories and results of selected researches, we designed the modified UTAUT model, which consists in identifying factors and their relations influencing the acceptance and use of the educational software. Based on the theoretical analysis of these nine theories the model was generated which reflects the impact of factors on the acceptance and use of educational software by participants of chemistry as a general-education subject instruction in the Czech Republic. On this basis a research tool was designed in the form of a questionnaire with 5-level scale (see Questionnaire items) for the verification of the model. Research sample will consist of approximately 400 teachers of chemistry as a general-education subject in the Czech Republic. With this sample size confidence interval of 5% at 95% confidence level is expected.

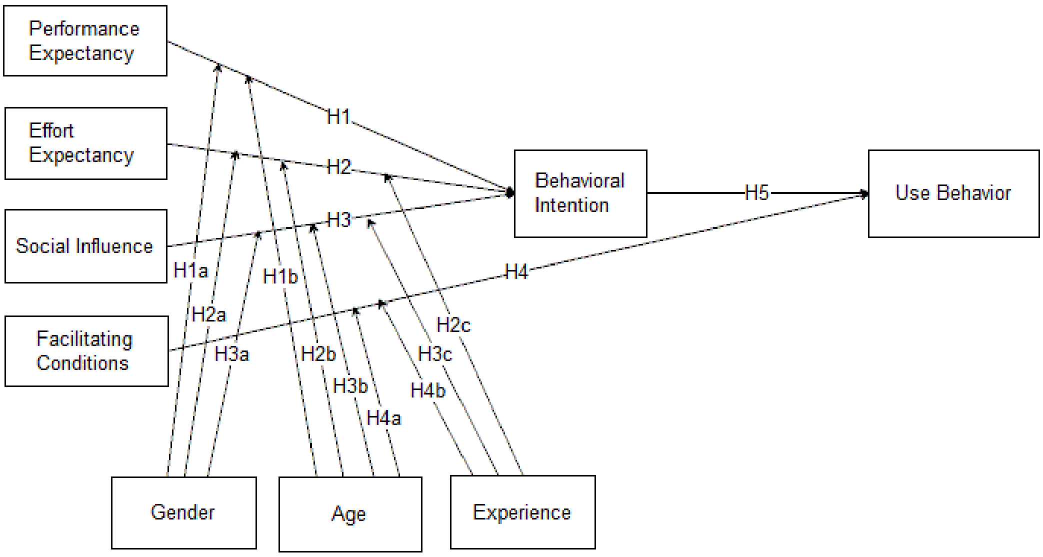

Figure 12: Research model and hypotheses based on UTAUT.

Research hypotheses relating to the modified UTAUT

The key point of our analysis in the preparation of research tools to identify factors influencing the use of educational software in chemistry education in the Czech Republic is to formulate hypotheses that are built on the relation within the UTAUT model (see Figure 12). We were inspired by a series of researches based on this theory during production of their formulations, (Chiu, & Wang, 2008; Van Raaij, & Schepers, 2008; Terzis, & Economides, 2011; Paola Torres Maldonado, Feroz Khan, Moon & Jeung Rho, 2011; Thomas Singh & Gaffar, 2013; Wong, Teo, & Russo, 2013). The hypotheses are as follows:

H_1: Performance Expectancy has a significant effect on behavioural intention regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

- H_{1a}: Performance Expectancy affects men's and women's behavioural intention differently regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.
- H_{1b}: Performance Expectancy affects young and old teachers' behavioural intention differently regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

H_2: Effort Expectancy has a significant effect on behavioural intention regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

- H_{2a}: Effort Expectancy affects men's and women's behavioural intention differently regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

H_{2b}: Effort Expectancy affects young and old teachers' behavioural intention differently regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

H_{2c}: Effort Expectancy affects experienced and inexperienced ICT users' behavioural intention differently regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

H_3: Social influence has a significant effect on behavioural intention regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

H_{3a}: Social influence affects men's and women's behavioural intention differently regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

H_{3b}: Social influence affects young and old teachers' behavioural intention differently regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

H_{3c}: Social influence affects experienced and inexperienced ICT users' behavioural intention differently regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

H_4: Facilitating conditions have a significant effect on the use of educational software for instruction of chemistry as the general education subject.

H_{4a}: Facilitating conditions affect the use of educational software for instruction of chemistry as the general education subject of young and old teachers' differently.

H_{4b}: Facilitating conditions affect behavioural intention of experienced and inexperienced ICT users differently regarding the acceptance and use of educational software for instruction of chemistry as the general education subject.

H_5: Behavioural intention has a significant effect on the use of educational software for instruction of chemistry as the general education subject.

Questionnaire items

As we mentioned above, the UTAUT theory identifies a number of factors. Their degree can be measured by scaled items in Table 1. Each item is rated on a 5-grade scale expressing approval or disapproval. These items are common in many researches using the UTAUT theory (e.g. Thomas Singh & Gaffar2013), we modified phrasing of items from their researches to the context of our planned questionnaire survey.

Table 1. The Questionnaire Items based on UTAUT.

Construct	Item Code	Item
Performance Expectancy	PE1	Educational software for instruction of chemistry as the general education subject is useful in education in general.
	PE2	The use of educational software for instruction of chemistry as the general education subject enables learners to accomplish tasks more quickly.
	PE3	The use of educational software for instruction of chemistry as the general education subject improves learners' performance.
	PE4	The use of educational software for instruction of chemistry as the general education subject increases learners' productivity.
Effort Expectancy	EE1	Educational software for instruction of chemistry as the general education subject are easy to use.
	EE2	Finding or using features in educational software for instruction of chemistry as the general education subject is easy.
	EE3	To learn how to operate the educational software for instruction of chemistry as the general education subject is easy.
Social Factors	SF1	People who influence my behaviour think that I should use educational software for instruction of chemistry as the general education subject.
	SF2	People who are important to me think that I should use educational software for instruction of chemistry as the general education subject.
	SF3	Headmasters are supportive of the use of educational software for instruction of chemistry as the general education subject.
Facilitating Conditions	FC1	In general, my school has support for the use of educational software for instruction of chemistry as the general education subject.
	FC2	I have the resources necessary for the use of educational software for instruction of chemistry as the general education subject.
	FC3	I have enough knowledge necessary for use of educational software for instruction of chemistry as the general education subject.
	FC4	Support of an individual or service is available when problems occur with the use of educational software for instruction of chemistry as the general education subject.
Behavioural Intention	BI1	I intend to use educational software for instruction of chemistry as the general-education subject in the next school year.
	BI2	I predict I will use educational software for instruction of chemistry as the general-education subject in my courses in the next school year.
	BI3	I have a plan to use educational software for instruction of chemistry as the general-education subject chemistry subject in the next school year.

Scale labels: 1 – Disagree, 2 – Partially disagree, 3 – Neither Agree nor Disagree, 4 – Partially agree, 5 – Agree

Conclusions

Being aware of the factors and their influence on the acceptance and use of educational software in the instruction of chemistry as the general-education subject, we should support the use of educational software in the classroom. That is, above all, through the preparation of the pre-service teachers and the continuing education of in-service teachers. The process of designing research tools to deliver meaningful results applicable in educational practice requires profound preparation and analysis of all relating circumstances. In our case we used a thorough analysis of the theoretical background of The Unified Theory of Acceptance and Use of Technology and the results of several relating researches, including our own ones. The emphasis was put on instruction of chemistry as the general-education subject and related attitudes of learners and teachers in the analysis of previous researches focused on the ICT implementation in teaching the natural sciences, particularly in laboratory activities. From our own previous researches we focused mainly on the effect of the use of educational software on learners' knowledge in instruction of chemistry as the general-education subject and the evaluation of educational software. Due to the development of technologies, the more frequent use of educational software is highly required. Based on the analysis of identified factors and their empirical verification under Czech conditions, recommendations should be defined towards a more effective use of educational software for instruction of chemistry as the general-education subject, as well as towards the development of methodologies for both the teachers and learners on how to integrate educational software within the instruction of chemistry as the general-education subject and how to use it.

Acknowledgements

This study supported by the Specific Research Project N. 2102/2015 of Faculty of Science, University of Hradec Kralove.

References

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes*, *50* (2), 179-211.

Bandura A. (1986). *Social foundations of thought and action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual review of psychology*, *52* (1), 1-26.

Belfer, K., Nesbit, J., Leacock, T. (2004). *Learning object review instrument (LORI): User manual*. Version 1.5. Retrieved November 1, 2014, from http://www.transplantedgoose.net/gradstudies/educ892/LORI1.5.pdf

Chang, M. K. (1998). Predicting unethical behaviour: a comparison of the theory of reasoned action and the theory of planned behaviour. *Journal of Business Ethics*, *17* (16), 1825-1834.

Chiu, C. M., & Wang, E. T. (2008). Understanding Web-based learning continuance intention: The role of subjective task value. *Information & Management*, *45* (3), 194-201.

Chroustova, K., Bilek, M. (2014a). Effectiveness of Educational Software in Science Education with Focus on Chemistry – From the Results of Research Projects. In Nodzyńska, M., Cieśla, P., Różowicz, K. (Eds.), *New technologies in science education* (p. 47–59). Kraków: Pedagogical University of Kraków.

Chroustova, K., Bilek, M. (2014b). On the efficiency of using didactic software in chemistry instruction. In Turčání, M., Drlík, M., Kapusta, J., Švec, P. (Eds.), *DIVAI 2014 – 10th International Scientific Conference on Distance Learning in Applied Informatics: Conference Proceedings* (p. 305–315). Prague: Wolters Kluwer.

Chroustova, K., Bilek, M. (2014c). The Comparative Analysis of Educational Software Focused on Natural Sciences from the View of Interactivity. Paper presented at *Information and Communication Technology in Natural Science Education – 2014*, 23 - 24 October 2014, Siauliai University, Lithuania.

Chroustova, K., Bilek, M. (2015). Současné výzvy pro využití didaktického softwaru ve výuce chemie – z výsledků výzkumných studií [Current Challenges for Educational Software Using in Chemistry Education – from Results of Research Studies]. *Media4u Magazine* [online], *12* (3), 24-29.

Davis, F. D. (1986). *A technology acceptance model for empirically testing new end-user information systems: Theory and results*. Doctoral dissertation. Cambridge, MA: MIT Sloan School of Management.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35* (8), 982-1003.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace1. *Journal of Applied Social Psychology*, *22* (14), 1111-1132.

Donnelly, D., McGarr, O., & O'Reilly, J. (2011). A framework for teachers' integration of ICT into their classroom practice. *Computers & Education*, *57* (2), 1469-1483.

Drent, M., & Meelissen, M. (2008). Which factors obstruct or stimulate teacher educators to use ICT innovatively? *Computers & Education*, *51* (1), 187-199.

Efe, R. (2011). Science student teachers and educational technology: Experience, intentions, and value. *Educational Technology & Society*, *14* (1), 228–240.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behaviour: An introduction to theory and research*. Available at: http://people.umass.edu/aizen/f&a1975.html.

Hernández-Ramos, J. P., Martínez-Abad, F., Peñalvo, F. J. G., García, M. E. H., & Rodríguez-Conde, M. J. (2014). Teachers' attitude regarding the use of ICT. A factor reliability and validity study. *Computers in Human Behaviour*, *31*, 509-516.

Ifenthaler, D., & Schweinbenz V. (2013). The acceptance of Tablet-PCs in classroom instruction: The teachers' perspectives. *Computers in Human Behaviour*, *29* (3), 525–534.

Kubiatko, M., & Vlckova, K. (2010). The relationship between ICT use and science knowledge for Czech Students: A secondary analysis of PISA 2006. *International Journal of Science and Mathematics Education*, *8* (3), 523-543.

Martinovic, D., & Zhang, Z. (2012). Situating ICT in the teacher education program: Overcoming challenges, fulfilling expectations. *Teaching and Teacher Education*, *28* (3), 461-469.

Oye, N. D., Iahad, N. A., & Rahim, N. A. (2014). The history of UTAUT model and its impact on ICT acceptance and usage by academicians. *Education and Information Technologies*, *19* (1), 251-270.

Paola Torres Maldonado, U., Feroz Khan, G., Moon, J., & Jeung Rho, J. (2011). E-learning motivation and educational portal acceptance in developing countries. *Online Information Review*, *35* (1), 66-85.

Park, S. Y. (2009). An analysis of the technology acceptance model in understanding university students' behavioural intention to use e-learning. *Educational Technology & Society*, *12* (3), 150–162.

Prestridge, S. (2012). The beliefs behind the teacher that influences their ICT practices. *Computers & education*, *58* (1), 449-458.

Rogers, E. M. (2003). *Diffusion of innovations*. Fifth Edition. The Free Press, New York.

Šorgo, A., Verčkovnik, T., & Kocijančič, S. (2010). Information and communication technologies (ICT) in biology teaching in Slovenian secondary schools. *Eurasia Journal of Mathematics, Science & Technology Education*, *6* (1), 37-46.

Taylor, S., & Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information Systems Research*, *6* (2), 144-176.

Thomas, T., Singh, L., & Gaffar, K. (2013). The utility of the UTAUT model in explaining mobile learning adoption in higher education in Guyana. *International Journal of Education and Development Using ICT*, *9* (3).

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1991). Personal computing: toward a conceptual model of utilization. *MIS quarterly*, 125-143.

Terzis, V., & Economides, A. A. (2011). The acceptance and use of computer based assessment. *Computers & Education*, *56* (4), 1032-1044.

Tosuntaş, Ş. B., Karadağ, E., & Orhan, S (2015). The factors affecting acceptance and use of interactive whiteboard within the scope of FATIH project: A structural equation model based on the Unified Theory of acceptance and use of technology. *Computers & Education*, *81* (February 2015), 169-178.

Valtonen, T., Kukkonen, J., Kontkanen, S., Sormunen, K., Dillon, P., & Sointu, E. (2015). The impact of authentic learning experiences with ICT on pre-service teachers' intentions to use ICT for teaching and learning. *Computers & Education*, *81* (February 2015), 49-58.

Van Raaij, E. M., & Schepers, J. J. (2008). The acceptance and use of a virtual learning environment in China. *Computers & Education*, *50* (3), 838-852.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27* (3), 425-478.

Voogt, J. (2010). Teacher factors associated with innovative curriculum goals and pedagogical practices: differences between extensive and non□extensive ICT□using science teachers. *Journal of Computer Assisted Learning*, *26* (6), 453-464.

Wilson, E. V., & Lankton, N. K. (2004). Modeling patients' acceptance of provider-delivered e-health. *Journal of the American Medical Informatics Association*, *11* (4), 241-248.

Wong, K. T., Teo, T., & Russo, S. (2013). Interactive whiteboard acceptance: Applicability of the UTAUT model to Student teachers. *The Asia-Pacific Education Researcher*, *22* (1), 1-10.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 68, 2015

Advised by Ivana Šimonová, University of Hradec Králové, Czech Republic & Jarmila Kmeťová, Matej Bel University, Banská Bystrica, Slovakia

Received: *November 11, 2015* Accepted: *December 25, 2015*

Kateřina Chroustová	Mgr. in Education of Chemistry and Mathematics for High School, Ph.D. Student of Didactics of Chemistry, Department of Chemistry, Faculty of Science, University of Hradec Králové, Rokitanského 62, 50003 Hradec Králové, Czech Republic. E-mail: katerina.chroustova@uhk.cz Website: http://www.uhk.cz
Martin Bílek	PhD., Professor of Didactics of Chemistry, Department of Chemistry, Faculty of Science, University of Hradec Králové, Rokitanského 62, 50003 Hradec Králové, Czech Republic. E-mail: martin.bilek@uhk.cz Website: http://www.uhk.cz
Andrej Šorgo	Ph.D in Biology, Associate Professor of Biology Didactics, Faculty of Natural Sciences and Mathematics, University of Maribor, Koroška cesta 160, Maribor, Slovenia. E-mail: andrej.sorgo@uni-mb.si Website: http://www.fnm.uni-mb.si/