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PERCEIVED USABILITY OF INFORMATION AND COMMUNICATION TECHNOLOGY AND ACCEPTANCE OF VIRTUAL FIELD TRIPS BY LOWER SECONDARY STUDENTS, UNDERGRADUATE STUDENTS AND IN-SERVICE TEACHERS

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Abstract. *In the present research the results of 288 lower secondary schools in-service teachers, 192 undergraduate students and 211 lower secondary school students from Slovenia were analysed in terms of importance of fieldwork and the information and communication technology (ICT) as a solution for supporting or replacing fieldwork itself. The main aim of the analysis was to compare the points of view in all stages: from students to teachers. Also, comparisons with international data obtained as part of TIMSS and TALIS studies were made. The analysis showed that participants tend to acknowledge a very positive effect to this kind of learning, despite the obstacles connected therewith. A comparison of the usage of ICT at home and in the school environment, as predicted, showed that students tend to be more digitally competent than their teachers. Also, the statistically significant difference pointed out that older teachers are less favourable towards ICT in education than their younger colleagues.*

Key words: *biology education, information communication technology, lower secondary education, teaching/learning strategies, virtual field trip.*

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Introduction

Fieldwork as a teaching method in educational settings, such as field trips and excursions, has been recognised as one of the crucial methods for achieving key competences in science and technology (European Parliament, 2006), and 'the evidence from research carried out around the world is that fieldwork can have a range of beneficial impacts on participants' (Dilllon et al., 2006), since the introduction of science through students' inquiries, critical thinking and solving the applicable problems were found crucial for learners of the 21st century (Jacobson, Militello, & Baveye, 2009; Šorgo & pernjak, 2012). It was also found that the learning approach affects students' attitude towards Biology (Usak, Ulker, Oztas, & Terzi, 2013). As a rule outdoor students are exposed to the natural environment through active participation and practical work, which usually makes them better at connecting theory with practice (Savery, 2006; Simmons, 2008). Because of various obstacles that teachers face during the organisation of outdoor activities, virtual field trips were found to be an effective solution for overcoming them (Tuthill & Klemm, 2002; Puhek, Perše, & Šorgo, 2013). Despite recognised insufficiency of virtual field trips (Spicer & Stratford, 2001), i.e. they do not enable students any real natural experience, in some cases (e.g. financial issues, oversized groups, athletes and special education) the missing part can be replaced with the achievement of other competences (Puhek, Perše, & Šorgo, 2011), especially by

acquiring competences connected with language, mathematics, learning to learn, cultural awareness, technics and digital competence (Ferarri, 2012). A virtual environment is also much more forgiving towards mistakes that students make during the learning process, which provides them with the opportunity to explore innovative solutions (Smetana & Bell, 2012). As Sahlberg (2011) pointed out, fear of failure does not engender creativity, which could be reduced with the assignment during an actual virtual field trip. Nevertheless, the social component of development should not be neglected in schools, where one can also determine the advantages of less social activities. Research shows aggressive and socially rejected students may have fewer opportunities to receive assistance from their peers (Vršnik Perše, Kozina, & Rutar Leban, 2011) and virtual environments could thus offer them support they seek.

Nevertheless, virtual fieldwork seems to be one of the most promising possibilities for engaging students into the learning process and thus generating their motivation (Chan, Hodgkiss, & Chan, 2002; Cox & Su, 2004; Kubiatko & Halakova, 2009). Considering the era and the circumstances which the society is in at the moment, the information and communication technology (ICT) knowledge is not something young generations should or could be taught by the adult generation in terms of transmission of knowledge. The aim and focus in education should be to keep up with the development of the ICT and its applications and to use them competently during the teaching process in terms of stimulating students' interest. There are four contexts for academic engagement of students: computer games, technological innovations for teaching and learning that are implemented in schools, computer applications developed specifically for promoting motivation and self-regulation in users, and the Internet (Corno & Mandinach, 2004; Alexander & Winne, 2006). All four contexts can be adapted by teachers for improving students' achievements and motivation. Also, the ICT was found to be at its most effective when used as a teaching supplement, as learning support, as encouragement for students' reflection and as promotion for cognitive dissonance (Smetana & Bell, 2012).

The analysis of the international TIMSS (Trends in International Mathematics and Science Study) 2011 data reveals that internationally almost half of the students have teachers that report of computer technology being available for teaching science (Martin, Mullis, Foy, & Stanco, 2012). Interestingly, science achievements in TIMSS show no significant differences between students who have access to ICT and those who do not (Martin et al., 2012). TALIS (Teaching and Learning International Survey) 2009 data shows that 25.1 % of lower secondary school teachers in Slovenia and 24.7 % of teachers on international average have expressed the need for further development in the ICT area (OECD, 2009). However, developments of new teaching tools are almost meaningless if teachers do not recognise their added value for teaching practice (Šorgo, Verčkovnik, & Kocijančič, 2010). As the main reasons against using ICT in teaching, teachers stated their lack of time, lack of resources and insufficient computer literacy (Kopcha, 2012; Yapici & Hevedanli, 2012). Therefore one could assume that for teachers it is not training in their ICT skills that could improve their attitude towards using it in classroom more frequently, but only a gradual increase of using it. This will make them more comfortable and will simultaneously also change their attitudes towards the importance of including ICT in teaching.

Research Focus

The aim of the research was to compare lower secondary school students', undergraduate students' and in-service teachers' points of views in terms of usability of ICT in teaching and acceptance of virtual field trips in biology teaching. Also, a comparison with the international analyses (TIMSS 2009 and TALIS 2011) was made.

In this part of the study, two main research questions were taken into consideration:

a) Are lower secondary students more accustomed to using ICT than teachers?
b) Are lower secondary students (providing they have better ICT competences) more favourable to virtual field trips than undergraduate students and in-service teachers?

Methodology of Research

General Background of Research

The study was performed by compiling questionnaires from three different studies (Puhek et al., 2011; Puhek, Perše, & Šorgo, 2012; Puhek et al., 2013), where parts of instruments were identical. It was conducted in 2011, and there where a total of 691 questionnaires obtained from Slovenian lower secondary schools of which there were 211 lower secondary students, 192 undergraduate students and 288 in-service teachers. All teachers whose teaching subject was biology and their students from all (450) Slovenian public lower secondary schools were invited to participate and all participants volunteered for participation based on invitation. Also a comparison with the results of the TIMSS study was made.

Sample of Research

The study sample consisted of 211 (30.5 %) lower secondary school students (aged 13 and 14), 192 (27.8 %) undergraduate students (students of university educational programmes) and 288 (41.7 %) lower secondary school teachers. The research sample consisted of 170 (24.6 %) males and 510 (73.8 %) females. The data about the gender of research participants were missing for 11 (1.6 %) persons since they refused to reveal this information. Beside their role (a lower secondary school student, an undergraduate student or a lower secondary school teacher), participants were additionally classified by their ability to use the computer. As evident from the results of Likert scale instrument, 108 (15.6 %) participants marked their knowledge as "poor", 302 (43.8 %) as "good" and 279 (40.5 %) as "excellent".

Research Methods and Statistical Analysis

The study was based on anonymous questionnaires, which consisted of three parts. First part covered 11 statements about the importance of the real field work. In the second part, the usability of ICT at home and in learning/teaching purposes was analysed. Finally, the third part covered 15 statements about the acceptance of virtual field work. Participants marked their opinions on a scale from 1 = "do not agree at all" to 5 = "totally agree". The reliability of combined data was tested with Cronbach's alpha that was calculated 0.88 for ICT usage and 0.65 for points of view about real and virtual field trips. According to Nunnally (1978) only the second instrument was less reliable, while the coefficient was under 0.70, but still in the range recognised by some authors as moderate and acceptable for educational studies (e. g. Dhindsa & Chung, 2003). Particular ICT activities were presented by means of descriptive statistics, where the mean (M) and standard deviation (SD) of each activity were exposed. A factor analysis (PCA with Varimax rotation and Kaiser normalisation) was performed to combine statements about real and virtual field trips into factors. The reliability of data for a factor analysis was tested with KMO (0.70) and Bartlett's Test of Sphericity ($p < 0.00$). The factors with Cronbach's alpha over 0.55 were taken as reliable (Dhindsa & Chung, 2003). The final statistical analyses of factors were conducted using nonparametric tests (Erceg-Hurn & Mirosevich, 2008), where the Mann-Whitney, Kruskal Wallis and Jonckheere-Terpstra Tests were found to be most suitable (Field, 2009). Additionally, the effect size (r) was calculated; the value of 0.1 was considered a small effect, the value of 0.3 a medium effect and the value of 0.5 a large effect (Field, 2009). Results that were statistically significant were those with values (p) lower than 0.05. The analyses were conducted by means of the statistical package IBM SPSS Statistics 21.

Results of Research

Comparison of ICT Usage between Lower Secondary School Teachers and Students

The usage of different ICT activities was compared between teachers and students by means of descriptive statistics (undergraduate students did not participate in this research part). As expected from previous studies (Šorgo et al., 2010), students mainly use ICT for completely different activities than

their teachers (Table 1). Teachers generally use (home) computers for lesson preparations, to search for information on the Internet and to use the Office tools. On the other hand, students spend more time on social networks, using communication tools and doing seminar and project work.

Table 1. Comparison of different ICT activities at home for 288 in-service teachers and 211 lower secondary school students, ordered by difference between means.

Usage of ICT at home	Teachers		Students		Difference between means	Rank test		Effect size
	Mt	SD	Ms	SD	Ms-Mt	p	Z	r
IV4 - Having fun on the Internet (social webs, forums, blogs)	1.41	0.57	2.97	0.95	1.56	0.00	15.21	0.71
IV2 - Playing games	1.14	0.39	2.40	1.12	1.26	0.00	13.83	0.64
IV7 - Communicating (e-mail, MSN, Skype)	1.97	0.42	2.85	0.92	0.88	0.00	11.79	0.55
IV13 - Project and seminar work	1.94	0.61	2.81	0.86	0.87	0.00	11.08	0.52
IV6 - Developing software (programming)	1.17	0.43	1.75	1.03	0.58	0.00	7.12	0.33
IV3 - Searching for data on the Internet	2.18	0.50	2.72	0.92	0.54	0.00	7.28	0.34
IV9 - Learning by means of computer	1.79	0.55	2.24	0.89	0.45	0.00	5.93	0.28
IV1 - Using Office tools (MS Office, Open Office)	2.17	0.60	2.47	0.79	0.30	0.00	4.78	0.22
IV5 - Using e-learning materials (Wikipedia, e-textbooks)	2.01	0.47	2.30	0.77	0.29	0.00	4.76	0.22
IV11 - Designing web pages	1.29	0.54	1.58	0.94	0.29	0.01	2.62	0.12
IV12 - Using library databases	1.54	0.54	1.59	0.75	0.05	0.77	0.29	0.01
IV8 - Using e-maps (Geopedia, Google Earth)	1.80	0.56	1.77	0.81	-0.03	0.10	1.65	0.08
IV10 - Lesson preparation	2.30	0.61	1.97	0.88	-0.33	0.00	5.30	0.25

Students also use ICT statistically significantly more often ($p < 0.00$) than teachers (Figure 1), whereby the main differences are time spent on playing games ($Z = 13.83$; $p = 0.00$; $r = 0.64$) and social networks ($Z = 15.21$; $p = 0.00$; $r = 0.71$). The calculated effect sizes for these activities were high (Table 1). The majority of teachers do not use them at all, while the majority of students spend at least one hour per day on social networks or playing games. On the other hand, teachers use ICT slightly more often than students for lesson preparations (a negative difference between means). No statistically significant difference in the usage of ICT was obtained only for the online use of library databases and use of e-maps, such as Geopedia or Google Earth. In both cases the effect size was small.

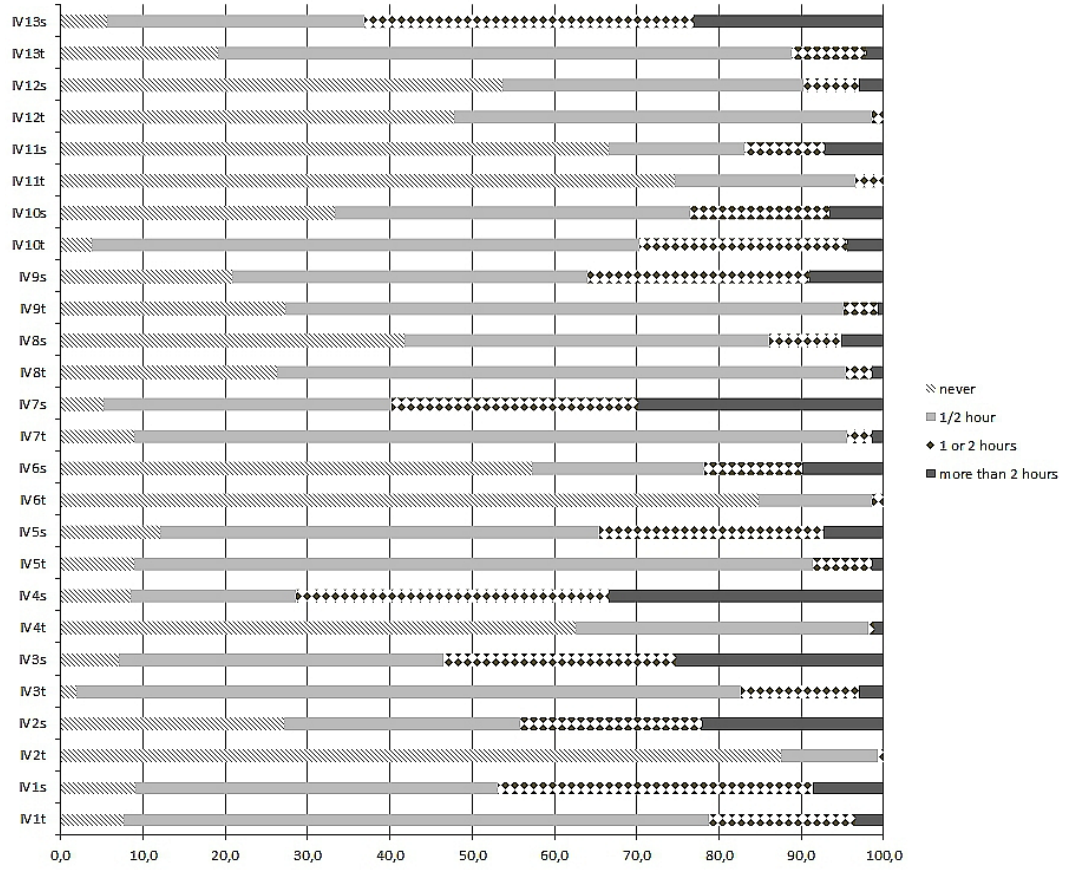

Figure 1: Frequency (%) of different ICT activities at home for 288 in-service teachers ("t") and 211 lower secondary school students ("s").

Acceptance of Real and Virtual Reality Fieldwork

The given statements about real and virtual fieldwork were used in factor analysis (explaining 48.34 % of variance), where three factors were extracted (Table 2). The first factor (F1) covered issues about the importance of real field trips, the second factor (F2) explained questions about the usability of virtual field trips and the third factor (F3) discussed statements about the suitability of virtual field trips for teaching. Non-parametric tests (Kruskal-Wallis and Mann-Whitney Test) were used to test the influence of different variables on given factors. Statistically significant differences were found only for the gender, persons' roles and their ability to use computers.

Table 2. Rotated factor loading with eigenvalues of factors F1 (Importance of real field trips), F2 (Usability of virtual field trips) and F3 (Suitability of virtual field trips).

Statements about real and virtual field trips	F1 - Importance of real field trips	F2 - Usability of virtual field trips	F3 - Suitability of virtual field trips
Fieldwork is an important teaching method.	0.72		
Fieldwork should be used more often (at least once per month).	0.71		

Statements about real and virtual field trips	F1 - Importance of real field trips	F2 - Usability of virtual field trips	F3 - Suitability of virtual field trips
Fieldwork is unavoidable.	0.68		
I usually find virtual tools through web browsers.		0.73	
I often find and use virtual tools in teaching/learning.		0.59	
Virtual fieldwork is especially useful as support and training.		0.53	
Virtual fieldwork cannot replace real fieldwork.		0.51	
Virtual fieldwork is not only for playing. It also enables serious work.			0.65
Working on virtual field trips is not merely a waste of time.			0.65
I find myself sufficiently experienced to use the computer.			0.63
Fieldwork can be supervised only by teachers and not by professionals.			0.49
Factor loading	1.86	1.79	1.67
% of Variance	16.94	16.27	15.13
Cronbach's alpha	0.62	0.56	0.50

The gender analysis revealed significant differences in factor 2 ($H(1) = 18.20$; $p < 0.00$), where females tend to be more interested in virtual field trips than males ($J = 42325.5$; $Z = 4.27$; $r = 0.17$). Despite a significant difference and a relatively noticeable effect size, because of the non-equal sample distribution, findings have been retained. The analysis of persons' roles revealed significant differences in factor 1 ($H(2) = 18.28$; $p < 0.00$) and factor 2 ($H(2) = 70.08$; $p < 0.00$). The Jonckheere-Terpstra test showed statistical trends of higher ranks in importance of real field trips for in-service teachers, compared to undergraduate students and students in the final place ($J = 57247$; $Z = 2.35$; $r = 0.09$). A similar trend was detected in terms of acceptance of virtual field trips ($J = 56071$; $Z = 2.84$; $r = 0.11$), where teachers found them more usable for teaching than students. On the other hand, students find virtual field trips more suitable for teaching than undergraduate students and teachers in the last place ($J = 57247$; $Z = 2.46$; $r = 0.10$). Despite statistically significant differences, the measured effect sizes regarding the role were small (0.09 to 0.11), which could indicate that the persons' role is less important in terms of acceptability of virtual field trips than other impacts. The analysis of persons' ability to use the computer revealed significant differences in factor 1 ($H(2) = 39.303$; $p < 0.00$) and factor 2 ($H(2) = 85.22$; $p < 0.00$). Users that declared themselves as having excellent digital competence have found virtual field trips to be more usable than users with poor ICT knowledge ($J = 42520$; $Z = 9.02$; $r = 0.43$). At the same time, they were also more aware of the importance of real field trips than their colleagues ($J = 38265$; $Z = 6.01$; $r = 0.29$). Both effect sizes were medium.

Discussion

It was established that teachers' attitudes about the usage of ICT for school work could be assigned in three groups: a positive attitude and actual use for work (office tools, e-mail, Internet), a positive attitude but no actual use (presentations, virtual laboratory, data loggers) and a negative attitude and no actual use for work (games, programming) (Šorgo et al., 2010). Present results revealed similar findings, the majority of teachers used computers only for lesson preparations, searching for information on the Internet and as office tools. It was stated that teachers usually implement technologies in student-centred

approaches instead of teacher-centred approaches (Inan, Lowther, Ross, & Strahl, 2010). Also their usage in schools is mosaic and underpinned with attitudes and opinions of teachers (Šorgo et al., 2010). A comparison of results from teachers with those from students revealed that students mainly use ICT for different kind of activities than their teachers. They generally spend more time on social networks, using communication tools and doing seminar and project work (Inan et al., 2010). Students also use ICT much more often than teachers (Jones, Ramanau, Cross, & Healing, 2010; Yapici & Hevedanli, 2012). Because of a stronger connection of youngsters with the new technologies in particular (Jacobson et al., 2009; Kubiatko & Halakova, 2009), different names, such as digital natives, net generation, generation y, appeared for them (Jones et al., 2010; van den Beemt, Akkerman, & Simons, 2011; So, Choi, Lim, & Xiong, 2012). However, it was also noticed that not all generations are homogeneous and therefore do not articulate in a single clear set of signs (Jones et al., 2010).

The international TIMSS data (Martin et al., 2012) confirm these findings. Students from Slovenia reported that 82.7 % of them use the computer at home every day and additional 14.3 % use the computer at home once or twice per week. Internationally 61.9 % of students report that they use computers at home every day and additional 19.0 % use computers once or twice per week. On the other hand, students do not report everyday use of computers in school very often. In Slovenia 32.45 % of students report that they never or almost never use computers at school and 31.70 % of them report that they use computers at school at least once per week. Internationally 24.9 % of students report that they never or almost never use computers at school, but over 56.0 % report that they use computers at school at least once per week. This indicates that students are regular users of computers and other ICT technologies (and can therefore be considered competent users), however, schools in Slovenia do not include computers in the teaching process regularly and thus do not make use of these competences. When analysing teachers' data it becomes evident that teachers do not feel very confident about computer technology, which can be considered as one of the reasons why computers are not included in the teaching process as much as they could be. In Slovenia teachers of 44.3 % of students strongly agree with the statement that they feel comfortable using computers in their teaching, while internationally teachers of 48.5 % of students feel very comfortable using computers as part of their teaching process (Martin et al., 2012). Considering TIMSS 2011 data for Slovenia, science teachers of 47.0 % of students report that their students have computers available for use during their science lessons and internationally 45.6 % report that the students have computers available for use during their science lessons (Martin et al., 2012). The potential for using virtual fieldwork is therefore moderately present and still needs to be improved. When analysing the potential of computers in teaching, the TIMSS 2011 results reveal data on how often students perform scientific procedures or experiments on the computer and how often they study natural phenomena through simulations on the computer. For Slovenian students was reported that only 21.1 % of students have teachers that instruct them to do scientific procedures or experiments on the computer at least once per month and internationally 28.1 % of students have teachers that instruct them to do scientific procedures or experiments on the computer at least once per month. And likewise for Slovenian students was reported that 30.3 % have teachers who instruct them to study natural phenomena through simulations on the computer at least once per month, whereas internationally there are 29.6 % of students whose teachers instruct them to study natural phenomena through simulations on the computer at least once per month. There is however no evidence provided of frequency of usage being related to students' achievements in science in TIMSS 2011 (Martin et al., 2012).

In the second part, the views about the real and virtual field trips were analysed through three factors: the importance of real field trips, the questions about usability of virtual field trips and the suitability of virtual field trips for teaching. The gender analysis revealed that females tend to be more interested in virtual field trips than males. The result is opposite to the majority of other studies, where authors found males to be more technical types and females more natural types (Cooper, 2006; Kubiatko & Halakova, 2009; Kennedy-Clark, 2011; Lamanauskas & Augiene, 2011). It was also stated that the impact of gender could fade when other factors (age, beliefs, affection by others etc.) are taken into consideration (Sang, Valcke, van Braak, & Tondeur, 2010; Vekiri, 2010). The analysis of persons' roles revealed significant differences in the importance of real field trips for in-service teachers, compared to undergraduate students and students in the last place. A similar trend was detected in terms of acceptance of virtual field trips,

where teachers found them more usable for teaching than students. Similar research agreed that teachers could (by means of their experience) evaluate the effectiveness of technology more easily, but at the same time they could also reasonably understand the importance of natural experience (Spicer & Stratford, 2001; Chan et al., 2002; Cox & Su, 2004; Kennedy-Clark, 2011). On the other hand, students find virtual field trips more suitable for teaching than undergraduate students, where in-service teachers take the last place. Other studies have revealed that teachers do not agree on the usability of virtual field trips equally (Inan et al., 2010; Sang et al., 2010; Kennedy-Clark, 2011), because younger teachers are generally more enthusiastic about the importance of virtual fieldwork than more experienced teachers (Puhek et al., 2013). Younger students were found to be more interested in ICT than their older colleagues (Kubiatko & Halakova, 2009). What was revealed to be of greater importance than the role was the time spent in nature (Stott, 2010) or the subjects of interest (Usak et al., 2009), where biologists were pointed out as persons with a greater connection to nature than people from other fields (Puhek et al., 2011). The analysis of person's ability to use the computer revealed users that declared to have excellent digital competence are more favourably disposed towards virtual field trips than users with poor knowledge of ICT. At the same time, they were also more aware of the importance of real field trips than their colleagues. Similar findings were found for Slovenian teachers, where teachers with excellent digital competence were also more willing to use virtual tools than teachers with poor digital competence (Puhek et al., 2013). It seems that computer and general technology knowledge helps teachers be aware of the functions and capacity of the technology and their benefits for students' learning (Inan et al., 2010; Sang et al., 2010; Kennedy-Clark, 2011; Tømte, Ove, & Hatlevik, 2011; Kopcha, 2012). Lastly, it was found that applications would be more easily transferred into a classroom, if teachers could test them and prepare teaching materials beforehand using their home computers (Šorgo et al., 2010).

Conclusions

ICT is without doubt penetrating almost every part of our lives and therefore also the field of teaching and teaching education. It was found that the majority of students use ICT much more frequently than teachers and also use it for completely different activities. However, the examination of literature and practice highlights that the new technology is mainly used only for fun (social networks, communication) and not for training students' key competences. Although schools have the capability, resources and responsibility to use students' knowledge for their further motivation for learning other contents and also to teach them about the advantages and disadvantages of its usage, they frequently lack sufficient funds and human resources (in terms of the number and competence) to be able to teach the young generation through the usage of ICT. Analysing the real and virtual field trips nevertheless exposed the advantages and disadvantages of both.

The participating lower secondary school students, undergraduate students and in-service teachers tend to acknowledge a very positive effect of virtual field trips. Although students tend to be more digitally competent and closely connected to technology it could not be stated that they are also more willing to trade computers for natural experience. Instead of the persons' roles, the main significant difference turned out to be their ability to use computers. Persons that declared themselves as having excellent digital competence were also more favourable towards virtual field trips than users with poor knowledge of ICT. At the same time, they were also more aware of the importance of real field trips than their colleagues. Considering all of the teachers' and students' data it could be concluded that virtual field trips could not serve as a full substitute for real field trips, however, the new technology will surely gain in importance and should therefore be considered as a valuable opportunity to enrich the teaching experience by every (future) teacher.

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