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COMPARISON BETWEEN A REAL FIELD TRIP AND A VIRTUAL FIELD TRIP IN A NATURE PRESERVE: KNOWLEDGE GAINED IN BIOLOGY AND ECOLOGY

Abstract. *The research presents a case study in the scope of which real and virtual field trips have been compared. The emphasis was on determining the levels of knowledge gain effectiveness in the fields of biology and ecology. A pre-existing natural trail in the protected area of Maribor Island was chosen and digitized for the purposes of the study. During the development of the virtual trail, real fieldwork was simulated in order to ensure a valid comparison. In the spring of 2011, field exercise tests were conducted by means of a study sample consisting of 211 (8th grade) lower secondary school students. The results have generally shown minute differences between the levels of knowledge acquisition effectiveness between both field trips. The results have also led to the conclusion that the students participating in the real field trip were more successful in their performance regarding the exercises they had been assigned, which included real objects serving as tools supporting the students in their observation and investigation endeavours. On the other hand, the students participating in the virtual field trip were more successful with regard to computer-assisted exercises, where they were able to access additional information on more complex processes.*

Key words: *education, knowledge gain, lower secondary school, virtual field trip.*

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Introduction

In the present day, the lifestyle is becoming increasingly dynamic and the changes have also affected the field of education. On the one hand, in the time of a widespread crisis the educational systems are on a real trial regarding the financial, material and behavioural limitations and on the other hand we are bombarded with multimedia and computer applications in various fields. The goal of this study was to get an answer to the question whether virtual field trips could be considered a possible substitution for real field trips in biology and ecology in lower secondary schools with no drawbacks to the knowledge gain.

Provided that hands-on and practical activities are not undertaken in a "cookbook" manner (Šorgo & Kocijančič, 2011), they have been recognized as methods that tend to inspire inquiry, problem-solving thinking, creativity, and knowledge at higher cognitive levels (Prince, 2004). Such work keeps students mentally and often even physically active throughout the activities that engage them in collecting data, gathering information, analysing, evaluating, and problem solving (Michael, 2006). It may be even more beneficial if practical activities can be undertaken in nature, since the outdoors offers opportunities to study a variety of living animals, plants, and microorganisms to enliven, illustrate and investigate the biological principles and phenomena (Tranter, 2004). It has also been observed that students link theory to practice more easily and memorize it better when they see things in nature, compared to when they only hear about them in a classroom (DiCarlo, 2009; Puhek, Perše, & Šorgo, 2011). In the case of field trips, teachers are also confronted with the issues of the level of guidance. The students can be actively involved in the teaching process, when working individually or passively under teacher's guidance (Kent, Gilbertson, & Hunt, 1997). The role of the teacher in a field trip is either that of a guide or a supervisor; in the first case the teacher is the most active of all, whereas in the second case this activity is handed over to the student. The place where the field trip is carried out can also be compared to a "shop-window" for observation or to a place for experimentation. Domin (1999) defines four different teaching methods based on the product, method and course of work. Translated into the field trip these methods can be defined as expository, discovery, inquiry and problem based learning (Sørenson, & Kofod, 2003). Although some researchers pointed out that unguided instruction can be less effective, which may also have negative results when students acquire misconceptions or incomplete or disorganized knowledge (Kirscher, Sweller, & Clark, 2006; Klahr & Nigam 2004), it is broadly accepted that students can develop science understanding only by engaging in it as scientists. This means that they identify a problem, generate and analyse the evidence, interpret the evidence, and draw conclusions (Dean & Kuhn, 2007; Kuhn, 2007). Additionally, studies have shown that field trips play an important and irreplaceable role in providing learners with real life observation of the learning objects (Chang, Lin, & Hsiao, 2009). As it was stated, they engender attitudes and values that can integrate into communities, and also overcome mutual ignorance and misunderstandings of natural phenomena (Barker, Slingsby, & Tilling, 2002). At this point, tacit knowledge must be stated, because it is difficult or even impossible to transfer and express it verbally (Puusa & Eerikäinen, 2010). Finally, among biological disciplines, hands-on experience and fieldwork are especially important in ecology, where they offer students an understanding of the relationship between the organisms and their environment in nature (Chan, Hodgkiss, & Chan, 2002).

With the development of computers, many researchers have recognized their usability in laboratories and fieldwork in different ways. The first approach is to use them as a tool for real laboratory work, in particular for collecting, analysing, and presenting the data (e.g. data loggers, sensors). The second approach is to transfer some of the previously undertaken practical activities into virtual worlds (e.g. simulations). The third and final approach is to develop new virtual activities, something that had been incomprehensible in the past for various reasons (safety, costs), but has become a reality for the students, who have access to many platforms enabling them to conduct certain virtual experiments (e.g. second life). The majority of studies have proven virtual tools and the ability to apply them to be an effective training or supporting tool (Chan et al., 2002; Harrington, 2011; Mikropoulos & Natsis, 2011; Spicer & Stratford, 2001; Stainfield, Fisher, Ford, & Solem, 2000), a motivation for students (Kubiatko, Usak, Yilmaz, & Tasar, 2010) and a cost-effective alternative for overcoming various obstacles (Chang et al., 2009; Puhek et al., 2011; Stumpf, Douglass, & Dorn, 2008). Although the implementation of ICT (information and communication technologies), simulations or virtual laboratories cannot replace actual laboratories and field exercises (Bilek, 2010), virtual environments allow supplemental experiments to be performed quickly, requiring less equipment and student supervision than traditional experiments (Crouch, Shen, Austin, & Dinniman, 2008; Tignor et al., 2007).

Despite the fact that students tend to have a positive opinion about virtual field trips and the possibility of preparing for or revising after a real field trip, the majority of them are not keen on replacing the real experience with a virtual one (Puhek et al., 2011; Spicer & Stratford, 2001). However, sometimes teachers have no other choice (Puhek et al., 2011) than replacing real field trips with virtual ones (e.g. a study of temperate forests by students in the tropics, teaching students with physical disabilities, hospital schools, athletes etc.) (Chan et al., 2002).

Purpose of the Study

The purpose of the study was to develop and test a virtual field trip for lower secondary school students. A virtual environment was taken as one of the possibilities for addressing organisational, financial and other issues (safety, accessibility, motivation etc.). After the development stage was over, emphasis was placed on the effectiveness in knowledge gain in biology and ecology.

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Research Focus

The research question of the study was whether virtual activities and virtual field trips could replace classic hands-on activities in laboratories, nature centres, museums, parks, zoos, nature etc. Another question that arose was if this replacement could be effective. At this preliminary stage, three domains at the level of gaining knowledge and skills were taken into consideration:

a) Are there any differences in the levels of knowledge gain between both methods?
b) What could be predicted from the differences?
c) The applicability of those differences in school practice.

Methodology of Research

The Natural Trail on Maribor Island

Maribor Island is a unique river ecosystem near the centre of the city of Maribor (Slovenia). Because of its geomorphologic and botanical characteristics, it is under preservation as a nature reserve and serves as an important natural landmark. As such, the Island plays an important role for the citizens of Maribor: as an open-air swimming pool and a sports facilities area on one side and as a recreation and hiking area with a natural trail on the other.

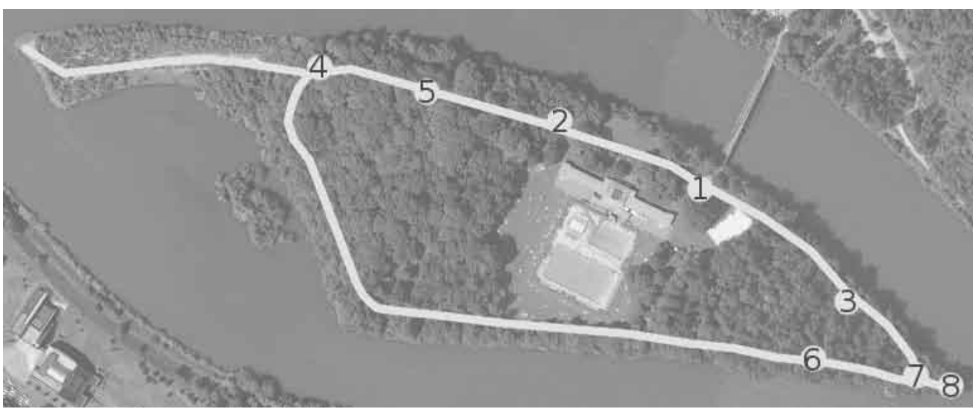

Figure 1. The natural trail on the Maribor Island with marked locations/exercises (http://e-ucenje.sinergise.com/).

In this proposal, eight exercises were prepared on an existing natural trail (Figure 1): The Maribor Island preservation area (a); Biodiversity (b); How old is a tree? (c); Deciduous trees (d); Is it true that moss only grows on the north side of a tree? (e); Coniferous trees (f); Measuring pH-values of the soil under the trees (g); and Animal adaptations (h). Each exercise was prepared as a self-standing point on the trail (a checkpoint), so that students finished with the trail after completing all exercises. Because the island is under preservation, it was necessary for the exercises to be at least neutral to the environment. For example, it was prohibited to leave the trail, to pick or gather plants, to dispose of and bury litter etc. An additional aspect to consider when preparing the exercises was that they were included in the Slovenian curricula for biology and ecology for lower secondary schools and that they were devised to train students' skills, their knowledge, and they are directed towards influencing how the students develop different points of views. As such, other teachers would be able to use the exercise materials in different Slovenian schools and on different occasions in the future. For example, there are over 160 educational trails in Slovenia that could be used for educational purposes (Ministry of the Environment and Spatial Planning, n.d.; Slovenia Forest Service, 2006).

After the exercises were outlined and the locations of exercises were determined on the real trail, the trail was digitized and inserted into Geopedia (http://www.geopedia.si/) – a web atlas and a web-based map of Slovenia, after which a virtual environment was developed and published on the web page (http://e-ucenje.sinergise.com/). With the intention of ensuring a valid comparison of both methods, the real work was simulated during the development of the virtual field trip. For example, during the virtual exercise of measuring the pH-values of the soil under the trees, the students had to begin with getting acquainted with the right order of the steps of the experiment procedure to be able to complete their task correctly and to read the results from a virtual pH level indicator.

Comparison between the Real Field Trip and the Virtual Field Trip

In this proposal, two different fieldwork methods were compared – the fieldwork method applied during the real field trip and the method applied within the scope of the virtual field trip. Two hypotheses were tested:

1) There is a significant difference in knowledge gain between exercises carried out in the real and virtual field trips.

2) Natural environment with first-hand experience contributes to students' better results in biology and ecology in lower secondary school.

The main goal was to observe the possible differences regarding the levels of knowledge gained when the first ("real-field-trip") group consisting of 78 (37 %) students visited Maribor Island to complete their assignment, while the second ("virtual-field-trip") group consisting of 133 (63 %) students stayed at school and completed their respective assignment by following the digitized trail on their computers. Both groups of students worked on the same exercises that were printed on worksheets, and in both cases students worked independently and in small groups (2-5 students). Independent work had been chosen to avoid teachers' influence on the results. In both cases work was done during lessons lasting two class hours (90 minutes) and was carried out as follows: 1) introduction of the trail and instructions about the work; 2) pre-survey; 3) exercises; 4) post-survey; 5) conclusion. The main difference between both methods (Figure 2) was that the first group of students was working with real objects in nature, while the second group performed the same activities in digitized form. While creating the exercises, special care had been taken in order to make the virtual exercises as similar to the exercises of the real field trip as possible.

Figure 2. The Exercise "How old is a tree," where the students' task was to determine the age of a tree during the real field trip (left) and within the scope of the virtual field trip (right).

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Participants

The study was conducted in May and June 2011, with a study sample consisting of 211 8th grade lower secondary school students, aged 13 and 14. Despite difficulties encountered in encouraging school headmasters to involve their students in the study, a total of 7 out of 14 headmasters of lower secondary schools located in the nearby area of the Maribor Island had granted their students permission to participate in the study. Teachers and students from those schools could be regarded as potential users of the natural field trail. Because of the characteristics of the study, the sample was not selected randomly. The research sample consisted of 98 (46.4 %) male and 110 (52.1 %) female students. The data about the gender of students participating in the research are missing for 3 (1.5 %) students. The students were also classified according to their biology grades in the previous school year (2009/2010). The students participating in the study obtained the following grades in biology: 11 (5.2 %) had obtained the grade "satisfactory" (2), 34 (16.1 %) had obtained the grade "good" (3), 55 (26.1 %) had obtained the grade "very good" (4), and 91 (43.1 %) of the students included in the study obtained the grade "excellent" (5). Additional answers to the questions regarding the students spending their free time either in nature or in front of the computer are presented in Table 1.

Table 1. Participants' daily free-time activities.

Free time	None		Half an hour		1 hour		2 hours		2 hours +		N/A	
	N	%	N	%	N	%	N	%	N	%	N	%
In nature	35	16.6	100	47.4	51	24.2	12	5.7	9	4.3	4	1.8
In front of the computer	1	0.5	26	12.3	45	21.3	56	26.6	79	37.5	4	1.8

Research Methods

The study was performed as a quasi experiment, based on pre- and post-survey questionnaires. The levels of knowledge gained were measured based on certain differences in answers on both questionnaires. The anonymous questionnaires devised for the purposes of the study constituted of six knowledge-based biology and ecology questions (Table 2). Students were requested to answer them independently and to the best of their respective abilities. The questions were selected to cover all exercises from the worksheets that the students were working with. The questions were not devised to test only the students' factual knowledge, but also to assess their higher order cognitive skills, such as analysis and evaluation (Anderson et al., 2001). During the evaluation, all questionnaires were scored the same way: 2 points were awarded for a correct answer, 1 point was awarded for a partially correct answer or a correct answer to a short question respectively, while no points were awarded for an incorrect answer. The reliability of the questionnaire was tested with Cronbach's Alpha that was measured 0.701. Nunnally (1978) has indicated 0.70 to be an acceptable reliability coefficient.

Table 2. Explanation of the exercises from pre- and post-survey questionnaires.

Worksheet topics	Aim of the exercises	Anderson and Krathwohl's taxonomy	Possible points
1. Dendrology	Determination of the age and calculation of the year of the best and the worst growing season.	applying, understanding	2
2. pH-value	Classification of three substances regarding the pH.	remembering	2
3. Illumination	Reading the data and complementing it.	understanding	2

Worksheet topics	Aim of the exercises	Anderson and Krathwohl's taxonomy	Possible points
4. Deciduous trees	Identification of the black alder tree.	remembering	1
5. Coniferous trees	Identification of four coniferous trees and marking of significant features.	remembering, applying	2
6. Biodiversity	Observation of the picture, counting of the species and determining the area with higher and lower tree biodiversity.	analyzing	2

Statistical Analysis

Because of non-normal distribution of the data (Kolmogorov-Smirnov Test), the statistical analyses were conducted using nonparametric tests (Erceg-Hurn & Mirosevich, 2008). The magnitude of change between the pre- and post-survey test scores for different exercises was assessed using the Wilcoxon Signed Ranks Test. In addition, the effect size was calculated from square root N and z-scores (Field, 2009). A statistically significant change in scores was that where Wilcoxon Signed Ranks test showed values of statistical significance lower than 0.05 ($p < 0.05$). The effect size (r) value of 0.1 was considered a small effect, the value of 0.3 was considered a medium effect, while the value of 0.5 was considered a large effect (Field, 2009). A linear regression was performed to determine the dependence of different attributes on the sum total of post-survey test scores. The analyses were conducted using the statistical package IBM SPSS Statistics 19.0.

Research Results

Differences in Knowledge Gained Comparing the Real Field Trip and the Virtual Field Trip

After comparing both methods, the results (Table 3) have shown that the students' knowledge levels have been improved in both cases. The main differences have revealed that the "real-field-trip" students were more successful at exercises where they were able to see and observe real objects in nature. This was the case with exercise No. 1, where students were able to count the age of a tree from a real stump ($Z = - 2.86$, $p < 0.00$, $r = 0.23$), and with exercise No. 4, where students were supposed to name trees after observing their leaves and bark ($Z = - 3.00$, $p < 0.00$, $r = 0.25$). On the other hand, the "virtual-field-trip" students were more successful with exercises where they were allowed to access the computer for detailed explanations on more complex or detailed processes. For example, an exercise where students benefited from being able to access the computer was exercise No. 6, where they were tested on understanding biodiversity ($Z = - 2.79$, $p < 0.01$, $r = 0.20$).

Table 3. Differences in sum scores between the pre- and post-survey results.

		Pre-survey		Post-survey		Rank test		Effect size
Exercise	Field trip	M	SD	M	SD	Z	p	r
Sum score	Real	6.33	2.37	7.18	2.04	-2.91	0.00	0.23
	Virtual	6.45	2.18	7.05	2.18	-2.96	0.00	0.18
1 (Tree rings)	Real	1.00	0.83	1.26	0.83	-2.86	0.00	0.23
	Virtual	1.52	0.78	1.42	0.80	-1.28	0.20	0.08
2 (The pH-scale)	Real	1.88	0.46	1.77	0.64	-1.35	0.18	0.12
	Virtual	1.77	0.63	1.81	0.57	-0.57	0.57	0.04

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		Pre-survey		Post-survey		Rank test		Effect size
3 (Illumination in the forest)	Real	1.49	0.74	1.43	0.71	-0.40	0.69	0.04
	Virtual	1.57	0.67	1.59	0.64	-1.29	0.20	0.09
4 (Identifying leaves)	Real	0.54	0.50	0.72	0.45	-3.00	0.00	0.25
	Virtual	0.44	0.50	0.50	0.50	-1.77	0.08	0.11
5 (Identifying keys)	Real	1.04	0.91	1.41	0.76	-2.52	0.01	0.21
	Virtual	0.94	0.75	1.28	0.74	-4.16	0.00	0.28
6 (Biodiversity)	Real	0.61	0.49	0.68	0.47	-0.63	0.53	0.06
	Virtual	0.51	0.50	0.69	0.47	-2.79	0.01	0.20

Note: M – mean; SD - standard deviation; r – effect size; p < 0.05

In addition, a statistical analysis was also conducted regarding gender differences (Table 4) and their respective biology grades (Table 5).

Table 4. Gender differences in sum scores between the pre- and post-survey results.

Gender	Field trip		Pre-survey		Post-survey		Rank test		Effect size
		N	M	SD	M	SD	Z	p	r
Male	Real	41	6.00	2.38	7.20	1.87	-3.23	0.00	0.36
	Virtual	57	5.61	2.04	6.56	2.19	-3.16	0.00	0.30
Female	Real	34	6.74	2.39	7.26	2.27	-1.17	0.24	0.14
	Virtual	76	7.08	2.08	7.41	2.12	-1.18	0.24	0.10

Note: M – mean; SD - standard deviation; r – effect size; p < 0.05

Table 5. Differences in biology grade sum scores between the pre- and post-survey results.

Grade	Field trip		Pre-survey		Post-survey		Rank test		Effect size
		N	M	SD	M	SD	Z	p	r
2 (Satisfactory)	Real	6	5.17	3.31	6.17	2.14	-1.24	0.22	0.36
	Virtual	5	5.20	2.78	5.00	1.41	-0.18	0.85	0.06
3 (Good)	Real	12	5.75	2.60	6.92	1.98	-1.39	0.17	0.28
	Virtual	22	8.00	1.63	8.27	1.70	-0.87	0.38	0.13
4 (Very Good)	Real	16	6.19	2.43	7.06	1.98	-0.95	0.34	0.17
	Virtual	39	6.10	2.37	7.08	2.24	-2.04	0.04	0.23
5 (Excellent)	Real	35	6.91	2.11	7.49	2.19	-1.69	0.09	0.20
	Virtual	56	6.39	2.01	7.07	2.07	-2.38	0.02	0.22

Note: M – mean; SD - standard deviation; r – effect size; p < 0.05

Prediction on the Differences

A linear regression was also performed between the pre- and post-survey results. The post-survey results have shown that only the difference in schools ($\beta = 0.19$, $p < 0.01$) and the difference in pre-survey knowledge level scores ($\beta = 0.42$, $p < 0.00$) were statistically significant. A statistically significant difference could not be identified for the chosen method (β = 0.00, n.s.), for the students' gender (β = 0.02, n.s.), for the biology grades the students had obtained in the school year that had ended the year prior to the time period of the study (β = 0.06, n.s.), for the students' respective favourite school subjects (β = 0.05, n.s.), or for the amount of free time the students had spent either in nature (β = - 0.05, n.s.) or in front of the computer (β = - 0.00, n.s.). The overall model fit was $R^2 = 0.30$. As presented in Figure 3 and Figure 4, the level of knowledge depends more on the respective school that the students had attended than on the method of choice – either real or virtual fieldwork.

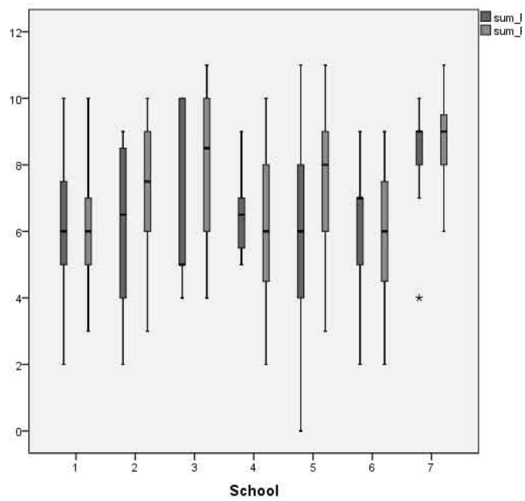

Figure 3. Box plots for the sum of pre- and post-survey scores regarding school.

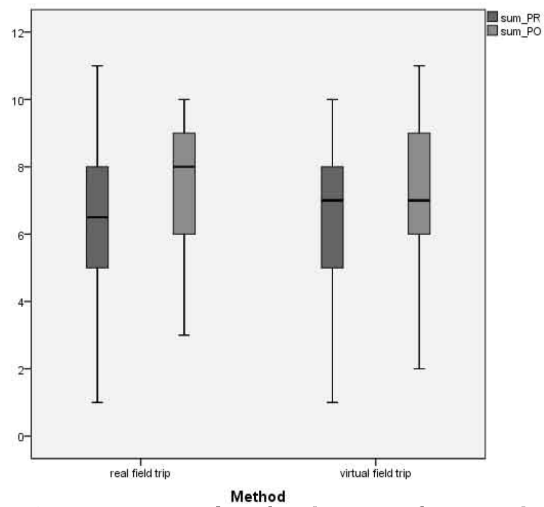

Figure 4. Box plots for the sum of pre- and post-survey scores regarding the method of the field trip.

Discussion

The presented research, even though performed on a relatively small sample, has indicated directions for an improved and extended study in the future. The main goal was to compare the real and the virtual field trips as individual methods regarding the differences in the levels of knowledge gained with either of the two and also to determine the prediction levels in each of the methods. As has been shown in similar researches, dealing with field trips or ICTs and the students' motivation for work, it is known that both (computers and the outdoors) are usually ranked higher (Fančovičová & Prokop, 2008; Kubiatko et al., 2010; Lamanauskas & Augiene, 2011; Ruchter, Klar, & Geiger, 2010; Šorgo, Verčkovnik, & Kocijančič, 2010). It has also been observed that an enjoyable learning environment could enhance the interest in the subject (Chan et al., 2002) and thus increase the level of knowledge gain.

The findings of this study have also revealed that after working on the exercises, the lower secondary school students progressed in knowledge ($p < 0.00$) in both cases. There have generally been no significant differences between the tested working methods. The real field trip has been shown to be slightly more successful, but the effect size was in the range between small and medium in both cases. Similar findings were also reported in other researches (Ruchter et al., 2010), revealing that mobile guides achieve similar effectiveness as traditional media and (Harrington, 2011) also that virtuality could reinforce the real experience. When analysing the scores for individual exercises it was shown that the "real-field-trip" students were more successful with exercises where they were able to see and observe real objects in nature, such as tree leaves, bark, and stumps (exercises nr. 1 and 4). This allowed the learners to apply their personal senses and have a real life interaction with the learning objects (Chang et al., 2009). On the other hand, their peers who worked within the scope of the virtual field trip were more successful with exercises where they were allowed to access the computer for detailed explanations on more complex or detailed processes. For example, an exercise where students benefited from being able to access the computer was exercise No. 6, where the students were tested on understanding biodiversity.

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In other words, students who worked with computers were statistically significantly more successful than their peers who were observing and counting plants in nature. A similar explanation could be applied for exercise No. 5, where both groups of students made the biggest progress regarding their levels of knowledge. Again, the students participating in the virtual field trip were slightly more successful because parts of the keys were already available on the computer which helped them understand how identifying keys works. The students participating in the real field trip were working with real tree branches and that focused predominantly on naming the materials they had worked with and were paying less attention to observing the characteristics of the materials, what had incidentally been the main purpose of the exercise.

Despite the fact that the post-survey results showed the gender of the students and their respective biology grades not to be statistically significant, additional analyses have been conducted. It has been determined that the male students progressed more with both working methods than female students. Similar researches pointed out male students to be technically more competent than female students (Cooper, 2006; Kubiatko et al., 2010). A particular study including Lithuanian upper secondary school students has also shown that girls are keener on dabbling in nature than boys, whereas boys enjoy conducting various tests and experiments at home more than girls (Lamanauskas & Augiene, 2011). With reference to the aforementioned studies, there might be a possibility that the questions were more suited to the male students than they were to female students (less factographic knowledge). With regard to biology grades and the working method, the results have shown that the students with either a good (3) ($p < 0.04$) or an excellent (5) grade ($p < 0.02$) progressed more within the scope of the virtual field trip. On the other hand, students with either a sufficient (2) or a good (3) grade in biology surprisingly revealed an increased effect size in the scope of the real field trip.

However, the linear regression additionally confirmed the suggestions provided. The post-survey results have shown that only the difference in schools and the difference in pre-survey knowledge levels were statistically significant ($p < 0.00$). The exercises, the chosen method, the students' gender, the biology grades the students had obtained in the school year that had ended the year prior to the time period of our study, the students' respective favourite school subjects or the amount of students' free time had no statistically significant impact on the scores achieved.

To sum up, the amount or the level of knowledge gain respectively depends more on the teacher and situation characteristic (Kennedy, 2010) than on the method chosen – real or virtual work. As it was observed in other subjects (Ruchter et al., 2010; Stumpf et al., 2008), virtual field trips and real field trips also appear to be equally effective methods for teaching biology and ecology in lower secondary schools. The majority of studies evaluating virtual field trips (Chan et al., 2002; Harrington, 2011; Spicer & Stratford, 2001) suggested using virtual field trips mainly as a tool for preparing for or for revising after a real field trip or as a substitute if real field trips are impossible to organize. Virtual field trips would be even more effective when used separately for selected exercises, where a computer could serve as a tutoring tool, providing detailed information on more complex or detailed processes occurring in nature (for example on osmosis, genetic crossing over etc.). Furthermore, there is a need for additional qualitative analyses with extended questionnaires.

Conclusion

Due to the advancements in computer technology, virtual tools for educational subjects such as biology and ecology have progressed immensely, thus reaching beyond the confines of a mere paradigm. Results from the presented study have shown, at least with regard to teaching biology and ecology at the lower secondary school level, that virtual field trips could be regarded as much more than merely a supporting tool for real field trips. In some cases, they might function as the more effective supplement. As it was presented in various previous studies, first-hand experience in nature brings the subject closer to the students in a much more influential and memorable fashion. On the other hand, a computer can provide students with media and software, which can assist in understanding and mastering complex processes by providing them with additional information and explanation. Despite work in the two cases being conducted in a completely different manner, the students faced similar issues. The secondary analyses pointed out that the key components influencing the difference in the levels of knowledge gained are the pre-survey knowledge level scores and the respective school that the students were attending. A statistically significant difference could not be identified for the chosen method, for the students' gender, for the biology grades the students had obtained in the school year that had ended the year prior to the time period of our study, for the students' respective favourite school subjects or for the amount of free time the students had spent either in nature or in front of the computer.

In other words, the amount or the level of knowledge gain respectively depends more on the teacher and the situation than on the method chosen – real or virtual work. In addition to the knowledge gain, it would be logical and sensible to include further domains such as skills and motivation in future studies on this particular subject.

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