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THE EFFECT OF OUTDOOR LESSONS IN NATURAL SCIENCES ON STUDENTS' KNOWLEDGE, THROUGH TABLETS AND EXPERIENTIAL LEARNING

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Abstract. *Experiential learning was introduced to support a child's concept development towards evolution scientific literacy. This study examined the effect of an experiential learning model (The Mobile Natural Science Learning - MNSL) on the knowledge of 4th grade primary school students in Slovenia, during natural science school lessons at the seashore through the use of tablets. Mobile technology provides authentic learning, assisting outdoor lessons providing material and environmental context in learning, which support the experience of a learner. In the experimental group (N = 95), outdoor learning in the seashore included Kolb's experiential learning cycle with the integration of tablets. In the control group (N=97), the teachers used concrete experience for exploring the seashore, excluding the Kolb's cycle. The data were collected by using two science knowledge pre and post – tests. The test items were classified into three TIMSS' cognitive domains: 1) factual knowledge, 2) conceptual understanding, and 3) reasoning and analysis. Differences between groups were analysed through Mann-Whitney U-test and showed that the experimental group had better learning outcomes than the control group. Findings indicate that the MNSL-model had a positive effect on students' achievement in science, more precisely in knowledge on marine organisms and life at the seashore.*

Keywords: *Kolb's experiential learning cycle, natural science, outdoor learning, seashore*

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Introduction

Being in the natural environment and experiencing nature are fundamental in children's life and for their learning experiences. Experiential learning about the environment through practical activities is important for students as it is motivating, stimulates learning and has a positive effect on the understanding of natural sciences (Abrahams & Reiss, 2012; Holstermann et al., 2009).

At the beginning of the 20th Century, Dewey had elaborated the gap between real life and school: knowledge needed to be taught in a decontextualized way, with written and spoken symbolic representation, in school, isolated from real life. Hence, forward, students learned, detached from their real-life, through abstract and text-based methods (Dewey, 1915). However, later it was reasoned that student's capability and experience, needed to provide a basis for teaching strategies (Dewey, 1938). Nowadays, most theory and pedagogical practices highlight among others the basic principles of instruction, with ongoing differentiation and individualisation, through contextualised learning in real life. With differentiation and individualisation as basic principles, student's needs and abilities were recognized, and had become in interplay with the principle of contextualised learning in real life. Furthermore, the principle required the inclusion of authentic learning activities and experiences, as compared to verbalism and narrative only (Blažič et al., 2003).

Mannion et al. (2011) critically discussed the teaching approaches, relying on propositions that science teaching relied on declarative knowledge and mental schemes, adjusted according to the cognitive level. Students learned to develop and manipulate representations of learning concepts and phenomena when engaged in authentic learning environments, and not just when using them cognitively. Ross and Mannion (2012) referred to Jardine et al. (2008) who indicated the need for the curriculum with real-life integrated, authentic activities (Jardine et al., 2008), firmly connecting school life with life experience. Dewey's theory of experience and inquiry, combined with the model of reflective thinking, had given ground to outdoor learning that

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indicated the importance of student's learning simultaneous with engagement in the local environment (Glassman, 2001). Outdoors education is defined as a working method where parts of everyday school time is moved out of the classroom into the local (outdoors) environment. Students learn by experiencing the real world: learning about nature in a natural environment; about society in the society; about the local environment in the local environment (Jordet, 1998, as cited in Jordet, 2009). In the thirties and forties, Dewey's model of inquiry was a framework for teaching science in the secondary school curriculum (Barrow, 2006). For Dewey, experiential learning was defined as learning by engagement in and through the local environment (Glassman, 2001). Following Dewey's philosophy, experience is the essence of any outdoor learning.

Conducting instructions outdoors has many stages. Mannion et al. (2011) have provided a taxonomy of outdoors activities that relate to the environment. Hence, teaching strategies could be: place-ambivalent (taught anywhere); place-sensitive (taking some account of place); and place-essential (only possible within a particular authentic place). Shaffer and Resnick (1999) have identified four types of authentic learning which are interdependent and mutually-supported: meaningful to a learner; related to real-life world; providing to think in the context of disciplines; where means of assessment reflects the learning process. The authors have discussed the use of computers for enhancing authentic learning and have identified three characteristics that provide an authentic learning environment: connectivity, modelling and representational pluralism (Shaffer & Resnick, 1999). With the influence of constructivism and the inclusion of microcomputers in education and the further development of mobile technology, the learning process becomes prevalently personalised and provides a contextualised learning experience within an authentic context.

A recent review regarding the integration of tablets has indicated that mobile technology can enrich learning in a variety of ways (Haßler et al., 2016), among them that tablets contribute to all domains of learning (Volk et al., 2017) and enhance the authenticity of learning in outdoor lessons. Herrington et al. (2010) proposed a list of nine characteristics of an optimal authentic mobile learning experience: 1) environments that reflect the way the knowledge will be used in real life; 2) authentic activities; 3) expert performances and the modelling of processes; 4) multiple roles and perspectives; 5) support to collaborative construction of knowledge; 6) reflection to enable abstractions to be formed; 7) enabling implicit knowledge to be made explicit; 8) coaching and scaffolding by the teacher at critical times; 9) valid assessment of authenticity of the learning tasks.

Theoretical Overview

The Outdoors Natural Science Lesson

Outdoor lessons have a great importance in natural science education (Bogner, 1998; Foster & Shiel-Role, 2011; Martin, 2003; Prokop et al., 2007) and have various positive effects that are reflected in more positive attitudes of students towards biology lessons and the natural environment. Effectively, they induce a better understanding of natural sciences concepts (Manzanal, Rodríguez –Barreiro et al., 1999; Prokop et al., 2007; Taş, & Gülen, 2019; Zoldosova & Prokop, 2006), as well as better environmental knowledge, and a more responsible attitude towards nature (Cheeseman & Wright, 2019; Erdoğan, 2011; Karyadi et al., 2018; Martin, 2003). Yildirim (2020) have found that outdoor learning in science teaching had a positive effect on students' attitude, motivation and success. Also, Karyari et al. (2018) has suggested that outdoor learning with introduction, exploration and interpretation steps, motivates students to active learning, constructing their understanding through ecosystem observation.

Within the Slovenian curriculum for Natural Sciences (regulated by the Ministry of Education), the teacher can practice outdoor lessons, in particular during science-day activities, and in planned field trip known as 'school of nature'. The aim of the science-day activities is to provide students with a positive attitude towards nature and understand the coexistence of man with nature. The main objectives are to create scientific literacy and to develop scientific methodology skills. Students gather and select materials and learn to reason, in order to form conclusions (Vodopivec et al., 2011). Science-day activities can be conducted at various locations: school surroundings, national parks, nature, or farms, parks, swamps, meadows, the seaside, zoos and botanical gardens, urban environments (cities), sites of urban and cultural heritage, museums, theatres, galleries, cemeteries, etc. (Ford, 1986). Besides, the seashore represents a location where teachers can fulfil various goals that cover content of biological, chemical, physical and environmental origin. After examining the research of Jesus-Leibovitz et al. (2017), it is clear that lessons at the seashore have a positive influence on the students' motivation, on bet-

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ter understanding of the concepts of natural sciences, and on understanding the importance of biodiversity. Guilherme et al. (2016) have observed that after viewing the seashore and learning about marine organisms, students adopted natural sciences concepts and better understood how marine organisms are adapted to their living environment. The diversity of this ecosystem offers students and teachers a new learning experience where students learn about the sea and marine organisms through practical activities. In doing so, they explore the seashore, determine the impact of humans on natural ecosystems, and learn about different types of organisms, the characteristics of weather, biodiversity, marine chemistry, food chains and clusters, endangered species of organisms, the adaptation of animals to the environment, the classification of marine organisms, and natural resources (Marine Science Adventures, 2016). Hartley, Thompson and Pahl (2015) have determined that students after activities dedicated to marine pollution, knew much more about the impact of human waste on life in the sea. The outdoor lesson could add to scientific literacy in evolution as well, for which the gap has been identified to be in early learning, a phase that is critical for children to learn about the concept of development (Nadelson et al., 2009).

Experiential Learning

Experiential learning is a fundamental strategy in primary science education. Kolb has defined experiential learning as *"… the process whereby knowledge is created through the transformation of an individual's experience."* (Kolb, 1984, p. 41). Experiential learning was based on the active role of the learner and his/her intrinsic interest (Dewey, 1938). Authenticity was essential to experiential learning, and increases the learner's motivation (Dewey, 1938), encourages the raising of personal commitment and diligence, while performing the active role during the learning (Behrendt & Franklin, 2014; Marenič Požarnik, 1987).

Various studies have confirmed the benefits of experiential learning (Djonko-Moore et al., 2018; Mehra & Kaur, 2010; Weinberg, Basile et al., 2015), where students observe and manipulate real objects and materials in the classroom. Positive effects of authentic learning are reflected in better results in knowledge tests and enhancement of environmental awareness (Mehra & Kaur, 2010), better understanding of biological processes (Orbanić et al., 2016), and higher motivation for acquiring knowledge from the natural sciences (Weinberg et al., 2015). It has been confirmed that outdoor learning followed by experiential learning, promotes deeper learning (Blomberg, 1967, Kolb, 1984; Scott & Boyd, 2016; Scott et al., 2012). Scott and Boyd (2016) have shown that outdoor activities with concrete experience had a good effect on improving science literacy and improved motivation. Moseley at al. (2019) have shown that the use of outdoor field trips followed by experiential learning positively changed students' beliefs about the environment. Torkar and Moharc (2013) have demonstrated that an outdoor camp, where students had plenty of opportunities to experiential learning about animal species, had a very good influence on the acquired knowledge on sweet/freshwater ecosystems including the plants and animals. Also, Golob (2011) has shown that the experience of observing life in water and around it, had an impact on the pupil's knowledge about small organisms and the aquatic environment. Hence, learning about the outdoors environment through experiential learning allows students to integrate their school knowledge with the lessons learned from the environment, which in turn contributes to better environmental behaviour (Golob, 2011).

In his theory, Kolb (1984) has suggested that there are four stages in the learning cycle with a different learning mode: concrete experience (CE); reflective observation (RO); abstract conceptualization (AC); and active experimentation (AE). The experiential learning cycle supports the learning objectives of scientific inquiry in the authentic natural environment, where students explore and gather material, on which they reflect and learn to reason, interpret and form conclusions. When students are in contact with the natural environment, they actively construct knowledge, while misconceptions could be confronted and transformed through the experiential learning cycle. In the contemporary natural science curriculum, a gap has been identified in the early learning of evolution (Nadelson et al., 2009). The experiential learning could address this gap by studying evolution through authentic learning activities that apply scientific methodologies and address evidence of evolution. When students are in contact with the natural environment, they actively construct knowledge, while the misconceptions can be confronted and transformed, through the applying experiential learning cycle. In the fourth grade curriculum, there are only a few learning objectives referring to the concept of evolution, with links between the environment and its organisms, the adaptation, and the influence of environmental changes in the environment.

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Mobile Technology Supporting Outdoor Lessons

For outdoor lessons, mobile technologies that include mobile- and smartphones, tablets, personal digital assistants (PDAs) and laptops (Kukulska-Hulme & Traxler, 2005), are among the most widely used information technologies in recent times. Mobile technology allows a student to participate in the learning process outside the classroom anytime and anywhere (Ekanayake et al., 2015). While using mobile technology, students interact with the authentic environment through words, images, sounds, animations and photos. Compared to traditional learning, mobile learning is more complex, primarily because students are exposed to the real world in which they handle material, compared to the digital world presented by the mobile devices (Chu, 2014). Positive effects on the knowledge and understanding of students have been observed regarding the use of mobile devices outside the classroom (Chen et al., 2005; Cheng et al., 2007; Churchill & Kennedy, 2008; Costabile et al. 2008; Lee; 2020; Liu et al., 2009; Pfeiffer et al., 2009), as well as on the motivation of students (Demir & Akpinar, 2018; Lai et al., 2007; Zacharia et al., 2016). Mobile devices can be used in the class to follow instructions (Dyson et al., 2009), to record results (Boyce et al., 2014), to record photographs and films (Boyce et al., 2014; Zacharia et al., 2016; Zimmerman & Land, 2014), to view pictures, photographs, short films, animations and simulations (Cruchill & Kennedy, 2008; Falloon, 2019; Tarng et al., 2015), to define organisms (Silva et al., 2011), to interact with the teacher (Nouri et al., 2014), and to solve problems (Lai et al., 2015). When using mobile technology outside the classroom, technology and practical work need to be carefully integrated, and purpose needs to be attributed to the whole activity (Rogers et al., 2010). According to Fotouhi-Ghazvini et al. (2011), to successfully integrate mobile technology into the learning process, one should firstly take into account the pedagogical needs and educational goals. The combination of mobile learning within a natural learning environment can acquaint students with a number of concepts related to natural sciences and help them to learn about the fundamental concepts in natural sciences teaching (Silva et al., 2011). With the development of mobile technology, the on-the-spot identification of organisms became simpler and more efficient, as many interactive identification keys began to emerge that are more fun and easier to use than conventional (paper-printed) identification keys (Pernot & Mathieu, 2010). Stagg, Donkin, and Smith (2015) have found that a mobile device key for identifying tree species represents an effective tool. Anđić et al. (2018) have demonstrated that digital dichotomous keys contribute to higher quality of acquired knowledge in comparison with printed dichotomous keys. Further, on the basis of questionnaires for students, Silva et al. (2011) have noticed that an interactive identification key is a good and friendly mean for learning botany, besides is much more accessible both for pupils and students. Mobile technologies can certainly be useful for outdoor lessons, but they need to be used as a learning aid only and not as a central activity during the class (Kacoroski, 2015).

Research Aim and Hypothesis

Teachers in Slovenia can practice outdoor lessons, in particular during science-day activities and in the schools of nature. But due to the complexity one should consider the following factors carefully while organizing outdoor lessons (VanBussel, 1992): the costs (Michie, 1998; Ross, Higgins, & Nicol, 2007; Zink & Boyes, 2006), securing safety and health of children (Rickinson et al., 2004), as well as the inadequate selection of appropriate outdoor learning strategies and lack of knowledge (Hanna, 1992; Nundy et al., 2009). Hence, this type of lesson is not carried out often. This is evident from Trends in International Mathematics and Science Standards (TIMSS) where the fraction of students with teachers that use research in more than half of their natural science lessons (like observing natural phenomena, watching their teachers carrying out experiments, as well as planning, presentation, interpretation and use of the results of the students' experiments, natural sciences study in nature) for Slovenia is 12%, significantly less than the international average that is 27% (Mullis et al., 2016). In addition, the evaluation of consecutive (2007; 2011; 2015) TIMSS results has shown that the use of computers in the Slovenian natural sciences classes in elementary schools is below the international average (Svetlik et al., 2008; Japelj Pavešić et al., 2012). This is also reflected in the non-use of mobile devices in outdoor lessons. It was indicated that the use of technology was 'undesirable' or even 'hated'. In view of the importance of outdoor lessons and the positive effects of tablet use, a model for outdoor lessons was created, entitled the Model of Natural Sciences School Lessons at the seashore by the Use of Tablets and Experiential Learning (or in short the *Mobile Natural Science Learning-model*, MNSL-model). The model was designed on the basis of Kolb's experiential learning cycle, upgraded with the implementation of tablets usage. In the present study the MNSL-model was tested directly at the seashore, because it was believed

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that the seashore offers many opportunities for performing effective outdoor lessons.

The aim of the research was to develop the MNSL-model of natural sciences school lessons at the seashore by the use of tablets for experiential learning and to find out its effect on the students' knowledge. In accordance with the given theoretical framework, the following research question was formulated.

RQ: What effect does using the MNSL-model have on fourth grade student's factual knowledge, conceptual understanding, reasoning and analysis to solve tests tasks, compared with students who had outdoor lessons according to a single Kolb's' experiential stage, with a concrete experience, but without the tablets (a more traditional way)?

Hypotheses to answer the research question were as follows:

H1: Students from the experimental group will be more successful in solving post-test tasks on the 1st TIMSS taxonomic level (the level of factual knowledge) than the students from the control group.

H2: Students from the experimental group will be more successful in solving post-test tasks on the 2nd TIMSS taxonomic level (the level of conceptual understanding) than the students from the control group.

H3: Students from the experimental group will be more successful in solving post-test tasks on the 3rd TIMSS taxonomic level (the level of reasoning and analysis) than the students from control group.

Research Methodology

Research Design

Preparations for the implementation of the MNSL-model started in the 2014/2015 school year. The pilot study based on the same research design was carried out during the same school year. The main research was conducted in the spring and summer months of the 2016/2017 school year (from March till the end of June), when fourth grade students attended the "school in nature" at the seashore. The outdoor lessons were conducted at theYouth health and Summer resort of Red Cross Slovenia - Debeli rtič, an established resort at the Slovenian coast, which every year receives a lot of students from various Slovenian schools according to the "school in nature" concept. The group of students that participated in the experimental (MNSL) model with the experimental factor was named the experimental group (EG), while the group of students who have benefited from the traditional (without experimental factor) teaching method was called the control group (CG).

The design was a non-randomized quasi-experimental research. Because it is better for students to remain in their established class, we used existing classes rather than implementing a randomized allocation of students to both of the groups. To exclude the effects of differences attributable to prior knowledge about the sea and sea organisms, intentionally schools from outside the coastal region were selected. Before starting the experiment, the initial equivalence between the groups was established. The equivalence was established in terms of gender and final grades in Mathematics, Slovenian language and Environmental sciences. Students from both groups took a pre-test to prove the initial equivalence of science knowledge. The experimental factor was the introduction of MNSL-model in the Natural Sciences curriculum, more precisely integrating the MNSL-model in the outdoor lessons (at the seashore). After examining various research about tablets and outdoor experimental learning (Chen et al., 2007; Silva et al., 2011), it was anticipated that a combination of outdoor and experiential learning at the seashore with the use of tablets would have a great impact on the student's achievements. The influence of the experimental factor on the learning achievement of the students was checked with a post-test, where the post-test score of the EG and CG were statistically compared, to determine whether the independent variable produced an effect (Johnson & Christensen, 2012). The independent variable was the experimental factor (MNSL-model) in the fourth grade of primary school. The research focused on students of the fourth grade, with the model prepared to the curriculum of Natural Sciences and Technology accordingly (Vodopivec et al., 2011). Learning objectives from the natural science curriculum were to:

- Recognize the most common types of plants and animals in the immediate seashore environment.
- Link the external appearance of an animal to its environment, way of life, sex, etc.
- Show that living beings are adapted to the environment in which they live, and that to a certain extent they can adapt to changes in the environment.

Figure 1 shows the representation of the research design.

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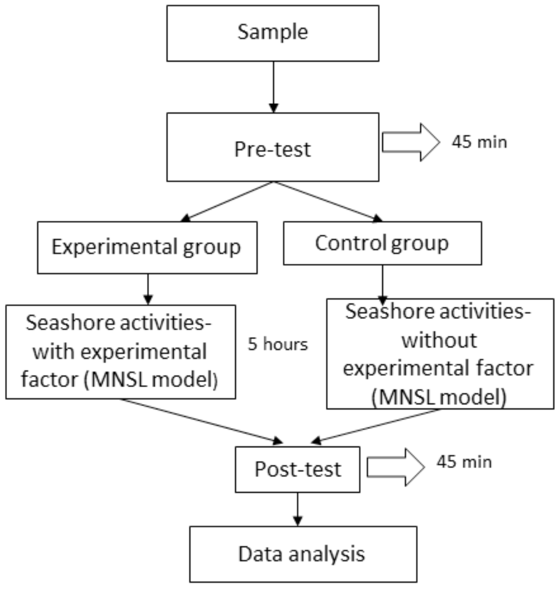
Figure 1
Research design



Sample

The research included 192 students from the fourth grade (with an average age of 9 years) of 8 different Slovenian primary schools. 95 students were designated to be the EG and 97 to the CG. The groups were equal in terms of gender, with 53.6% of boys and 46.4% of girls in CG, and 52.6% of boys and 47.4% of girls in the EG. The groups were also equated according to their final grades in the school subjects of Mathematics (U = 4310; p = .662), Slovenian language (U = 4389; p = .473) and Environmental Sciences (U = 4214.5; p = .942) from the 3rd class. All classes from the EG had equal working conditions, i.e. tablets, didactic tools and live material to perform experiential learning while students from the CG had a lesson without intervention. All the participants were informed about the aims of the research. The research was carried out with a written consent of the parents and the school authorities. The research included classroom teachers who teach in the fourth class of elementary school. After we explained the course of experiment, an agreement from the teachers, was also obtained. Anonymity of all participants was ensured.

Instrument and Procedures

Pre-test

To establish the initial equivalence regarding background knowledge of science, the students from both groups performed a pre-test 10 days before the experiment was conducted. The pre-test focused on living and non-living things, adaptation of animals and the knowledge about earth, all items taken from TIMSS (2007; 2011). The pre-test contained items that were classified into three TIMSS cognitive domains: four items were at the level of knowledge of factual processes (the lowest level – 40 %), four items were at the level of conceptual understanding (the intermediate levels – 40 %), and two items related to targeted thinking at the highest-level, i.e. reasoning and analysis (the highest levels – 20 %). The items were scored through points (0-2 points). The difficulty index (D) for individual items was calculated, which ranged between .38 – .88, while the average difficulty index was .67, with the recommended difficulty level ranging from 30 – 70 %, corresponding to .3 – .7 (Hingorjo & Jaleel, 2012). An item's difficulty is the percentage of students taking the test and answering correctly, which is a representative measure of how difficult the question was to answer (Patock, 2004).

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Post-test

One week after the experiment, the students from both groups took a post-test. The purpose of the post-test was to investigate whether the research intervention had a good impact on the students' knowledge about the seashore. The post-test contained items that were classified identical to the pre-test (see above). The post-test consisted of 10 items (multiple-choice items and short answers). The items were scored through points (0-3 points), with the total number of points for the post-test reaching 18 points. The difficulty index (D) for individual items was calculated, which ranged between .45 – .85, while the average difficulty index was .67, and the index was in the recommended range (.3 – .7).

Objectivity, validity and reliability of pre- and post-tests

The objectivity of the testing was guaranteed with the testers, in this case the teachers, who were acquainted with the detailed instructions for solving the pre- and post-test. In this way, the influence of the tester (teacher) on the students in solving the tests was eliminated. The criteria for assessing both tests were determined in advance. The validity of both tests was verified by factor analysis of the means (Extraction method: Principal Component Analysis and Rotation method: Varimax with Kaiser Normalization), which demonstrated a variance of 23.13% for the first factor in the pre-test and the post-test showed a variance of 21.61%. Thus, both tests were constructively valid. The reliability of both tests was calculated by a factorization process based on factor analysis. Reliability by factor analysis indicates the extent to which the total variance is explained by all factors; the lawfulness is taken into account: $r_{tt =}$ The reliability coefficient (r_{tt}) was .786 for the pre-test and .711 for the post-test in both cases reliability can be accepted.

The lesson at the seashore of the Control Group

In the CG, learning at the seashore was experiential, but with only one stage of Kolb's learning cycle (the concrete experience). The teachers did not use any tablets to discover the seashore and for identification of the marine organisms. Instead, they used methods already established for exploring the seashore:

- searching for marine organisms along the seashore,
- identification of marine organisms with the paper identification key and the seacoast,
- frontal principle of classroom teaching about the sea and about marine organisms.

The lesson at the seashore of Experimental Group

In the EG, work at the seashore was conducted with the present model of teaching at the seashore (MNSL). The model is based on the principle of Kolb's experiential learning cycle (Figure 2) with all four stages: concrete experience, reflective observation, abstract conceptualization, active experimentation (Kolb, 1984). In the first part, the students had a certain period of time to search for organisms at the seashore; this part was devoted to a concrete experience. The direct experience and the importance of these activities for outdoor work and organism recognition have been confirmed by both our and foreign research (Tomažič, 2008; Yore & Boyer, 1997). The reflective observation was made by brainstorming, conversation between groups, and from rhetorical questions.

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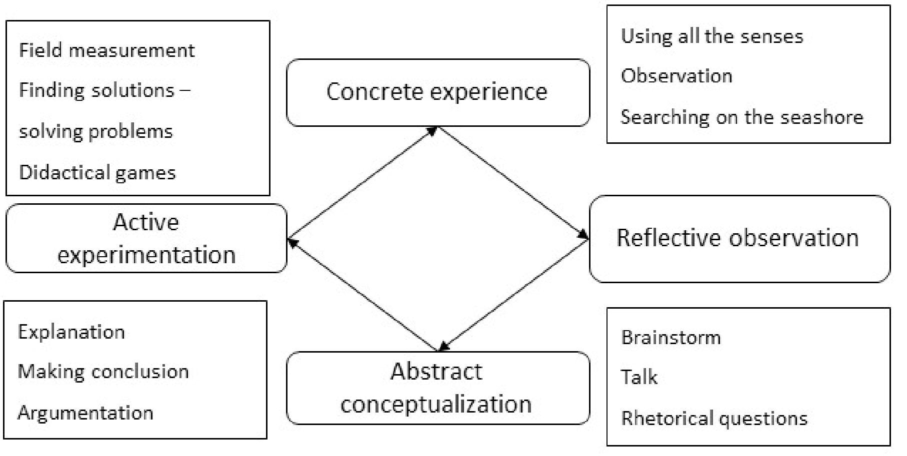
Figure 2
MNSL-model based on Kolb's experiential learning cycle



After exploring the seashore, tablets with the MNSL-model were introduced. Tablets were chosen because they are small and convenient, and easy to use in the field (Trinder, 2005), and were used during three learning contents ("Sea, do I know you," "Define the name of bivalves and sea snails" and "Marine detectives"). The tablet applications were designed in a way that students had the opportunity to actively learn and experiment with different parameters and data, thus gaining a good understanding of the sea and the adaptations of organisms to the coastal conditions (Table 1).

Table 1
Stages of MNSL

Learning content:	Goals of activity:	Integration of Tablets
"Sea, do I know you"	Get to know the basic characteristics of the sea. Determine and connect the state of time with the state of the sea. Prepare and perform simple experiments on the sea alone. Research the seashore in a group. Solving group worksheets.	Use of tablets – application "Sea, do I know you?" was developed in collaboration with the experts at the University of Ljubljana, Faculty of Computer and Information Science. Students used the application to check the results of different experiments. For example: students measured the temperature of the sea with a thermometer, then they marked the temperature on the thermometer in the application. If the temperature was correct, they got a star. The tablets were used in groups.
"Define the name of bivalves and sea snails"	Get to know the basic characteristics of molluscs (bivalves and sea snails). Name the most typical bivalves and sea snails of our sea. Get acquainted with the interactive identification key. Solving worksheets in pairs.	The interactive key was created using the NVU program (pronounced N-view, for a "new view"). Students used the identification key to identify the names of sea snails and bivalves on a tablet. They could choose between two options. Example (Figure 3): An animal with two shells or an animal with one shell. The tablets were used in pairs.

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Learning content:	Goals of activity:	Integration of Tablets
"Marine detectives"	Observe precisely. Connect marine organisms to the environment in which they are found. Using an interactive dichotomous identification key, without pictures. Solving group worksheets.	The application was developed in collaboration with the experts at the University of Ljubljana, Faculty of Computer and Information Science. Students acted like detectives and used the application to find marine organisms at the seashore. Example: The organism is very small, the organism has a smooth shell, the organism's shell is grey. The tablets were used in groups.

Figure 3
Example of application: Interactive dichotomous key

The emphasis was on the independent exploration of the seashore and the integration of all senses. Care was executed not to discourage students from exploring the environment by refraining time to be spent in exploring mode and noticing potential distractions, which was emphasized by authors of similar research (Bleck et al., 2012).

Data Analysis

The score from the science knowledge test through pre-testing and the score from the seashore knowledge test through post-testing were examined. The results were first quantitatively analysed at the level of descriptive statistics. The normality of distribution was verified by Kolmogorov-Smirnov and Shapiro-Wilk tests. If $p < 0.05$, the distribution was established not to be normal, and a non-parametric test should be used (Field, 2000). If the dependent variable was not normal, the differences in learning achievement and knowledge level between groups were analysed using the Mann-Whitney *U* - test (Field, 2000; Hart, 2001). The obtained data were analysed statistically, using the SPSS Statistics 22 (Statistical Package for Social Science) software package.

Research Results

Analysis of the Differences in the Pre-test Knowledge of EG and the CG Students at all Three Taxonomic Levels

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Table 2
Mann-Whitney U- test statistical parameters of the students' pre-test scores

Group	*N*	Mean rank	Mann-Whitney *U* test	
			U	*p*
CG	97	95.53	4393.5	.663
EG	95	96.48		

N-number; U – Mann – Whitney U test

There were no statistically significant differences in the initial science knowledge between the EG and CG groups (U = 4393.5; p = .663).

Table 3 clearly shows that there were no statistically significant differences in solving items at the cognitive domains of TIMSS' taxonomy. The pre-test scores of both groups were comparable prior to the experiment, which means that students from both groups had similar prior science knowledge.

Table 3
Mann-Whitney U-test statistical parameters of the students' pre-test scores on the first TIMSS cognitive domain (TCD1), on the second TIMSS cognitive domain (TCD2), and on the third TIMSS cognitive domain (TCD3)

Cognitive domain	Group	*N*	Mean rank	Mann-Whitney *U* test	
				U	*p*
TCD1	CG	97	92.14	4185.00	.289
	EG	95	99.98		
TCD2	CG	97	94.28	4392.50	.652
	EG	95	97.77		
TCD3	CG	97	95.53	4513.50	.900
	EG	95	96.48		

Analysis of the Differences in the Post-test Knowledge of Students in the EG and the CG at all Three Taxonomic Levels

After completion of the experiment, both the students from the CG and the EG took the post-test. The results of post-test are presented in Table 4. The EG students were more successful in solving items at all three TIMSS cognitive domains. Statistically significant differences were evident at all of the three TIMSS cognitive domains.

Table 4
Mann-Whitney U-test statistical parameters of the students' post-test scores (on TIMSS cognitive domains).

Cognitive domain	Groups	*N*	Mean rank	Mann-Whitney *U* -test	
				U	*p*
TCD1	CG	97	86.57	3644.00	.01
	EG	95	105.73		
TCD2	CG	97	81.42	3144.50	<.001
	EG	95	111.05		
TCD3	CG	97	85.70	3650.00	<.001
	EG	95	106.63		

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At the first cognitive domain (knowledge of factual processes), students in the EG were more successful in solving tasks than students from CG. The EG scored an average of 4.356 out of 5 points, students from CG reached 4.046 points, which was 0.31 points less than average in EG (Figure 4). Despite the small differences between the average group scores, statistically significant differences in post-test scores between the groups were detected (Table 4).

At the second cognitive domain (conceptual understunding), students from EG scored 1.142 more points than CG. The average of scored points in the EG were 5.875 out of 7 points, the average of CG were 4.733. (Figure 4), a statistically significant difference (Table 4).

The statistically significant differences between groups were evident at the third cognitive domain (reasoning and analysis), were students from EG reached 2.936 out of 6 points, which is 0.72 more than students in CG (2.216) (Figure 4).

Figure 4

Average number of points for the three cognitive levels for CG and EG students

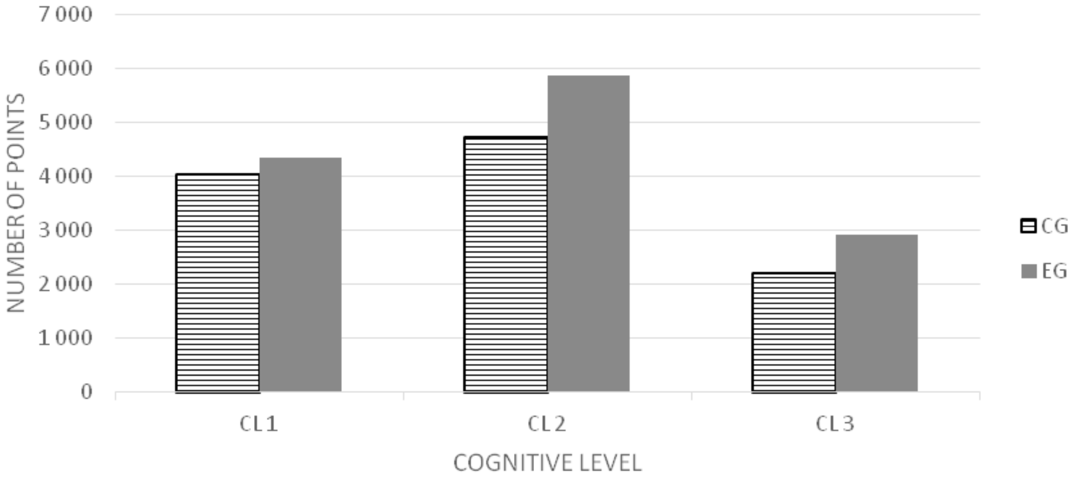

Figure 5 shows a difference between the groups in percentages of correct answers to the test items. Students from CG performed better for the third item (CG = 82.5 %; EG = 71.3 %), at the first cognitive domain (items 1, 2, 3. and 4). The items referred to the characteristics about the sea, especially to the tides.

The students from EG answered better for all items at the second cognitive level (items 5, 6, 7 and 8). Students from both groups had problems with the sixth item, about the adaptation of animals, and when the answers to this item were analysed, it was shown that 51.1 % of the EG students and 25.8 % of the CG students answered correctly.

The most demanding item for both groups was item 10, on the adaptation of animals, which was classified at the third cognitive domain. The results showed that 19.1 % of EG students and only 5.2 % of CG students responded completely correctly.

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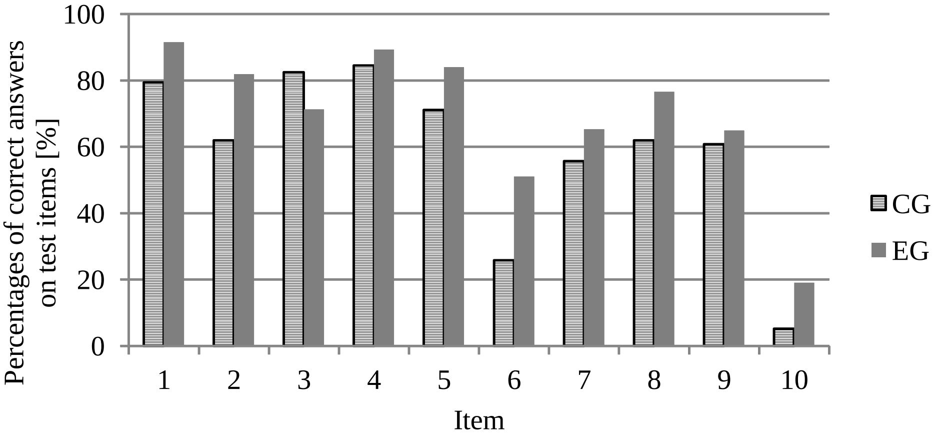
Figure 5
Percentages of correct answers on individual test items for CG and EG students



Note. Items: 1., 2., 3., 4. - cognitive level 1, items; 5., 6., 7. – cognitive level 2, items: 8., 9., 10.– cognitive level 3.

Discussion

In the research, it was focused on the impact of the MNSL-model on the knowledge about marine organisms and the seashore of 4th grade students. It were interested in whether a combination of experiential learning and the use of tablets has a positive impact on the acquisition of new knowledge among students. Prior to the experiment, the students from both groups solved a pre-test to check their initial natural sciences knowledge, and it was found that the students of both groups had relatively equal knowledge on natural sciences at all cognitive levels, which was also reflected in the final number of points achieved. There were no statistically significant differences between the groups (Table 3). As can be seen from Table 4, statistically significant differences occurred between the CG and the EG in the final test of knowledge at all three cognitive domains *(factual knowledge, conceptual understanding, reasoning and analysis*), as well as in the total number of points achieved. The post-test results indicated that students in the EG achieved statistically significantly results at solving items within the first cognitive level which refers to *factual knowledge* (U = 3644.50; p < .01). Hence, hypothesis 1 was confirmed, which predicted that EG will be more successful than CG in solving items on the level of factual knowledge (1st TIMSS taxonomic level). Statistically significantly higher results have been shown also at the second cognitive level (U = 3144.50; p <.001), which refers to the use of knowledge (confirming hypothesis 2 that mentions EG will be more successful than CG in solving items on the level of conceptual understanding (2nd TIMSS taxonomic level). The tasks in the third cognitive level address reasoning and analysis, and were statistically significantly (U = 3650.00; p = <.001). Thus, hypothesis 3 was also confirmed, which predicted that the EG will be more successful than CG group in solving items on the level of reasoning and analysis (3rd TIMSS taxonomic level). With the obtained results and the confirmed hypothesis, the research question of this study can be answered positively, and our study provides evidence that the MNSL-model had a positive effect on the fourth-grade students' achievement in science, more precisely, in knowledge about marine organisms and life at the seashore.

The MNSL-model emphasizes the experience of nature and the concrete experience that, according to many authors, plays an important role in the knowledge of organisms (Palmberg et al., 2015; Yore & Boyer, 1997), as well as in the students' knowledge (Jose et al., 2017; Tomažič, 2008). The model was upgraded and implemented with the use of tablets, that can also have a positive impact on students' knowledge and motivation, but only if they are appropriately included in the learning process (Volk et al., 2017). Previously, researchers mentioned about different problems that can arise by using tablets in outdoor settings. Huang et al. (2010) have found that students, using mobile devices to learn about plants, were more loud and disorganized than students using the classic printed plant guide. The authors believe that such behaviour can lead to enthusiasm, joy and interest in the actual operating of the mobile devices, thus, taking the focus away from the specific learning task. In research by Boyce et al. (2014), it was noticed that early-on problems arose during the arguing among students about who would hold the tablet.

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The students were indecisive about touching things in nature, fearing that the tablets would get dirty or damaged. Despite the fact that the present study tried to incorporate technology into the field of experiential outdoor learning, significant differences were not observed in all the tasks of the final test of knowledge. Tasks, where no differences were found, were focused on the characteristics of the sea (high tide, low tide and sea temperature). The students learned about the characteristics of the sea in a practical way, and also with the help of the "Sea, do I know you" application. The application did cause problems in students following instructions and performing measurements, i.e. at the integrating of the learning experience and in the performing of various tasks on the tablets. This is also emphasized by other studies (Costabile et al., 2008; Rogers et al., 2010).

Statistically significant differences in favour of the EG showed especially in the tasks where the emphasis was about adaptation and knowledge of marine organisms (tasks 1, 4, 5, 10) (Figure 5). In addition to experiential learning, in our model, the central role in learning about marine organisms was also the interactive identification key of bivalves and sea snails, which was loaded on the tablets. The identification key was easy to use, it had clear identifying characters that were also referred to as the advantages of interactive identification keys by other authors (Kirchoff et al., 2011; Pernot & Mathieu, 2010). The advantages of the present interactive identification keys compared to the paper identification key were the clarity and the number of photos. Students learned about the organisms by using the "Marine Detectives" application, wherein they had to study independently, observe well, and learn about the basic adaptations of organisms. Another important element of our applications was the fact that the tablet was a research tool, supporting experiential learning while articulating all stages of Kolb's cycle when gathering and manipulating outdoor material. Liu et al. (2009) have found that the mobile application with which students learned about wetlands as a living space, gained understanding on the importance of wetlands, and had a positive impact on the effectiveness of learning, as well as on the student's creativity and problem solving.

The MNSL teaching model has certain shortcomings which are mainly reflected in the lack of research material, the insufficient number of tablet computers, the lack of excursion preparation time, and in the incomplete design of the "Sea, do I know you" application.

In the future, it would make sense to record the student's statements directly during the exploration at the seashore, as this is the only way to obtain insight into what they are experiencing during the exploration of the environment. In addition, it would be sensible to check whether the acquired knowledge is permanent, and to repeat the post-test one year after the survey, so it could be reasonably assessed whether the MNSL - model exerts a positive impact on the students' knowledge.

Conclusions

Based on the evaluation of the research process and the obtained results of the interactive outdoor lesson that implemented the MNSL-model, we believe that the current MNSL-model is effective in to educating students and achieving good results in the final test of knowledge and that the students gained new knowledge related to marine organisms and the seashore, which was demonstrated by comparing the EG and CG results. The MNSL-model was designed to be used by teachers directly at the seashore, but it can also be used in natural sciences lessons, including in the classroom, if, for various reasons, students cannot go to the seashore. However, any outdoor lessons that place emphasis on experiential learning and the use of tablets need to be well planned and prepared, and this requires time and pro-activity of teachers. The MNSL-model offers Slovenian primary schools a new efficient learning tool, an interactive tablet to be used during outdoor lessons at the Slovenian coastal environments.

There is no ideal learning process to achieve lasting knowledge, as students have different needs and desires, and teachers have ever more tasks and less time to design and prepare effective lessons. The MNSL-model is merely a pebble in a comprehensive mosaic of learning and teaching natural sciences, which may help teachers and students learn about the basic characteristics of the sea and marine organisms.

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