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**INTERACTIVE ANIMATION'S POSSIBILITIES AND
LIMITATIONS FOR DEVELOPMENT OF ENVIRONMENTAL
LITERACY FOR PUPILS**

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Abstract

Collective and individual human actions have deformed life on the planet. Therefore, it is important to take care of this problem helping people understand environmental problems and make necessary actions. One of the methods to develop children's environmental literacy can be interactive animation. Interactive animation is one of new learning subjects; therefore, it is important to study the possibilities and limitations of this method in the field of environmental education. The problem under study is caused by the lack of research dealing with the development of the environmental literacy of primary school pupils through interactive animation. The research aims to reveal how the environmental literacy of primary school pupils can be developed by applying interactive animation. This study investigates data collected during the educational experiment. Qualitative content analysis of data has showed that interactive animation is an effective tool for improving environmental knowledge and environmental awareness in primary school children. However, the development of environmental literacy requires many more different methods. The data of the research are relevant to primary school teachers and creators of interactive animation, because they can help improve the development of the environmental literacy in primary school pupils and the creation of interactive animation for the effective environmental education of primary school pupils.

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Keywords: Enviromental literacy, education, interactive animation, primary school pupils.



1. Introduction

Global Education Monitoring Report (UNESCO, 2016) states that education is the main tool to ensure formation of active society responsible for environmental issues, society that would be aware of the importance of maintaining balance between sustainable environment management, lifestyle and economics. Therefore the methods that would help achieve the objectives of environmental education should be chosen responsibly: “Education has long been recognized as a critical factor in addressing environmental and sustainability issues and ensuring human well-being” (p. 7).

Environmental literacy involves environmental sensitivity, ecological and socio-political knowledge as well as knowledge of environmental issues, environmental skills and environmentally responsible behaviour (McBride et al., 2013). It also comprises motivation to participate in the activities of environment improvement and protection actively and wish to bring out personal values and to make decisions on environmental issues independently with regard to moral principles.

Various challenges are faced in the field of the environmental literacy development. Strife’s (2012) study “Children’s Environmental Concerns: Expressing Ecophobia” indicates that children are concerned with ecological situation escalated in the media. They feel insecure, unable to change the worsening situation of the planet. Most of them experience obvious anger and the feeling of despair in relation to environmental issues. In the context of Lithuania, the international study of students’ science literacy PISA-15 shows decline in the 15-year-olds’ science literacy results and environmental knowledge and skills (Dukynaitė et al., 2016). Consequently, it is especially important for teachers to select relevant educational measures contributing to the efficient development of environmental literacy.

Studies on the impact of interactive animation on children’s environmental attitudes (Toledo, 2015; Aydin, 2015; Praneetham & Thathong, 2016) demonstrate a positive effect on students’ understanding of environmental concepts, problem solving skills, knowledge about light pollution and energy saving, perception of importance of solving this problem and raising environmental awareness of global warming. However, there is still a lack of data on the possibilities to develop the environmental literacy of primary school pupils using interactive animation. Educators and scientists agree that focus on abstract and distant environmental issues such as tropical deforestation and global warming does not affect young children who are at the stage of concrete-operational thinking and are not able to handle global environmental problems (Sobel, 2008). Thus educators, parents and environmental organisations should critically review the ways of rendering environmental knowledge and educational strategies suitable for children of different age groups. Chawla and Flanders-Cushing (2007) claim that it is possible to resist the feeling of helplessness that people have when facing environmental issues if we contribute to social and environmental changes and work with other people. Activities involving children dealing with minor local problems, which do not exceed children’s cognitive abilities, are the best way to build their self-esteem and sense of capability, which, according to the studies, is an important factor in motivating environmental behaviour (Duffin et al., 2004).

Animation and cartoons are popular both in the fields of entertainment, advertising, education and in research (Zin, Nasir & Ghazali, 2010). Animation is an efficient tool in the process of learning drawing, mathematics and biology (Cohan & Hegarty, 2014; Aydin, 2015). Computerization of schools and classrooms make this film genre a popular educational instrument in many disciplines of general education

(Xiao, 2013). Research shows that cartoons may be an effective medium to develop children's social and environmental literacy. In addition, Zin, Nasir and Ghazali (2010) determine that interactive animation created by scientists themselves and based on traditional tales contributes to the development of children's socio-cultural skills. Aydin (2015) finds that computer cartoons in combination with additional activities in the nature have a positive influence on seventh-graders' knowledge about light pollution and the importance of solving this problem. The study on the influence of media cartoons on eighth-graders' environmental awareness and ecological problem solving skills conducted by Toledo (2015) shows that cartoons significantly improve understanding of environmental concepts and enhance problem solving skills; however, the findings reveal that knowledge and understanding of environmental issues are not enough for the change in behaviour and problem solving skills to happen. On the other hand, there has also been negative attitude towards animated environmental films. Starosielski (2011) in detail describes the critique that environmental animation receives in the academic world. Animated environmental films are criticized for being opposite to complex, rational and scientific knowledge that would enable viewers to address environmental problems (Starosielski, 2011). Cartoons, visual hyperbolization and simplification form a framework of environmental animation which does not comply with the discourse of balanced environmental philosophy and rational environmental issues faced by society.

A critical component in the interactivity chain is the development of learner's awareness, which includes learner's knowledge prior to learning activity and the knowledge they acquire in the course of the activity. Interactive animation may contain explanatory information; it may interact with the learner, and it may be used to test the knowledge (Xiao, 2013). This is not a final point in the integration of interactive animation in the interactivity process. It is more like an integrated part in the entire process where acquired and prior knowledge alter behaviour, thinking and emotions (Plass, Schwartz & Heidig, 2012). Moreover, interactive animation is able to create the mobility effect. This means that interactive animation may introduce environmental issues of distant places to students. Animation may transfer them into imperceptible, invisible world which cannot be caught in camera in reality; it may also be used to visualize environmental changes easily (Starosielski, 2011). Consequently, it may help overcome cognitive, emotional and geographical barriers as visual rendering of information improves thinking skills, understanding of a topic, recognition of ideas, whereas dynamic graphics of interactive animation may motivate students more than a static image (Mason, Lowe & Tornatora, 2013; Aydin, 2015).

2. Problem Statement

Integration of interactivity categories in the process of environmental literacy development becomes possible through interactive animation as this leads to mixed education. Some studies show the advantages of interactive learning (e.g. Tung & Deng, 2006; Domagk, Schwartz & Plass, 2010); other studies reveal a mixed result (e.g. Moreno & Mayer, 2005); the third group of studies deals with limitations and disadvantages of interactivity (e.g. Moreno & Valdez, 2005; Troseth, Russo & Strouse, 2016; Wang & Yang, 2016). Quality indicators of interactivity are identified in the theory of "submerging" interactivity (Pranskūnienė, 2013), yet they have not been applied to the study the development of children's environmental literacy. The problem under study is caused by the lack of research into the development of the environmental literacy of primary school pupils through interactive animation.

3. Research Questions

This study focuses on the possibilities of interactive animation to develop the environmental literacy of primary school pupils. There are following questions: How does interactive animation change the level of environmental knowledge of primary school pupils? How does interactive animation change the level of environmental skills in primary school pupils?

4. Purpose of the Study

The purpose of the study is to reveal how the environmental literacy of primary schoolchildren may be developed using interactive animation.

5. Research Methods

Qualitative research strategy was chosen for the study, and the methods of document analysis, educational experiment and semi-structured interview were used to collect data. The collected data were analysed employing the method of qualitative content analysis. This article introduced the results of the educational experiment (other results are presented in the work by Bendaraviciute-Kalinauskienė, 2017).

5.1. Sample

The following were the criteria for sampling the subjects for the educational experiment: third-graders; first-time users of the programme “Smart Robots”; pupils volunteering to participate in the educational experiment. The first subject under test (T1) was audacious, communicated freely, flicking everything, watching, took initiative, comments on what she saw and was curious. She solved mathematical tasks willingly and chose optional tasks, as well. The subject was good-humoured; stayed still, focused and engaged in watching interactive animation.

The second subject (T2) chose to watch animation without music in the background. The girl watched and completed the tasks in a focused and engaged manner; however, she manipulated animation only when told where to go and what to do. She was slightly shy. She was not fluent in task management, needed help at the beginning. Later she got used to the process and needed no further help. The participant was interested in animation and performed an optional task.

The third participant (T3) concentrated when watching animation, performed the tasks willingly. She was interested and critical, was not shy to state her opinion and communicate; when performing tasks, she understood what was expected of her and explored eagerly. She was initially slow with new tasks and their management, but later she became more fluent in the programme management.

The fourth subject under test (T4) was a timid, quiet and slower girl. She was ready to communicate and asked questions when uncertain. The subject stayed focused and engaged when watching animation and performing the tasks. She did not explore independently, waited for additional instructions from the investigator. Having started the task, she faced difficulties in task management, which later disappeared. She also completed an optional task.

5.2. Procedure

To ensure the quality of the study, the educational experiment was performed in the following stages (Rupšienė & Rutkienė, 2016): 1) interactive animation was selected and chosen for the educational experiment; 2) the environmental literacy of primary school pupils was assessed prior to the educational experiment; 3) two selected interactive animations were employed; 4) the environmental literacy of primary school pupils was assessed after the educational experiment; 5) analysis and evaluation of change in the participants' environmental literacy were performed.

This experiment aimed to determine change in environmental literacy after the application of interactive animation method to develop environmental knowledge, environmental awareness and environmental skills in primary school pupils. Two interactive animations about air and water pollution and recycling were chosen for the educational experiment: "How to separate waste" and "Efficient use of natural resources". They were chosen on the basis of characteristics, criteria and indicators of interactive animation for the development of the environmental literacy of primary school pupils (see Bendaraviciute-Kalinauskienė, 2017). When watching interactive animation, three interactive tasks were performed. The participants managed the course of animation and the settings for a soundtrack. One subject was studied in one day of the educational experiment. During the meeting, the subjects watched interactive animation and performed tasks. Change in the level of environmental literacy after the educational experiment was assessed.

The test was used to assess the participants' environmental knowledge, awareness and skills. 34 pictures and 26 questions in relation to the content of interactive animations were used. The pictures demonstrated examples of efficient and wasteful use of water, air pollution/ reduction of air pollution and rules for waste sorting. The subjects had to choose a picture which, according to them, showed correct environmental action and to reason their choice. Before picture demonstration, the study participants had to answer the questions testing their knowledge, understanding and skills at environmental literacy. The questions did not contain hints and their formulation did not affect pupils' knowledge and beliefs. After the educational experiment, the same pictures were used to assess the participants' environmental knowledge, understanding and skills. For example, the indicator "Environmental knowledge" included the question "What are natural resources?" before and after the educational experiment. The answers could be found in the interactive animation: "Natural resources are water, air, sun, forests and minerals". Each participant was interviewed four times, thus eight interviews in total and investigator's notes were analysed for the study (see Bendaraviciute-Kalinauskienė, 2017).

After the educational experiment data were collected, qualitative content analysis was performed. The assessment scale for measuring the level of the environmental knowledge, perception and skills of the participants was developed. The scale included very low (0), low (1), average (2), high (3) and very high (4) levels. For example, if the level was very low, it meant that the subject could not explain any of the two concepts presented, did not know the time needed for different waste to decompose, did not possess any knowledge about environmental issues and ways/possibilities to solve them. On the other hand, very high level referred to answers as thorough as those in the animation, to the subject's knowledge and ability to explain the both environmental concepts (i.e. nature pollution and natural resources) mentioned in the

animation in detail. The reliability of the study was ensured through the authors' discussion and consideration in which the joint opinion was reached and evaluation and level was agreed upon.

5.3. Research Ethics

The study followed the principles of research ethics, i.e. those of respect to personal privacy, anonymity and confidentiality, beneficence, non-maleficence and fairness (Žydžiūnaitė & Sabaliauskas, 2017). The participants were asked if they agreed to participate in the educational experiment voluntarily and if they did not object to being recorded. The contract between pupils and a school included a statement that pupils attending the respective school agreed to participate in studies. Therefore, additional written consents were not signed by parents, but the headmaster of the school submitted signed agreement. The topic and objectives of the study were introduced to the participants and the entire course of the study was explained to them. The participants' names were changed to ensure their anonymity (Bitinas et al., 2008). The facts presented in the interactive animations chosen for the educational experiment were true and ethical, thus causing no harm to the subjects. Moreover, the participants did not suffer any psychological, physical, material or social damage in the study process. The information presented by the subjects was solely used by the researchers; it was not transfer to the third parties or used in other studies.

6. Findings

This part of the article presents data according to the research questions, i.e. assessment of the third-graders' environmental literacy in terms of change in the level of environmental knowledge, awareness and skills. (I) refers to the assessment of environmental literacy before the educational experiment, while (II) denotes the assessment of environmental literacy after the educational experiment. Interactive animations are encoded by IA1 and IA2 and the participants' codes are T1, T2, T3 and T4.

6.1. Assessment of the third-graders' environmental literacy according to the level of their environmental knowledge

Assessment of the third-graders' environmental literacy according to the level of their environmental knowledge is presented in Table 01.

Table 01. Assessment of the participants' level of environmental literacy knowledge

Indicators	Before (I), after (II) the experiment	Study participants			
		T1	T2	T3	T4
Know environmental concepts	I	2	1	1	1
	II	3	2	3	2
Know how long it takes for different materials to decompose	I	1	0	0	0
	II	2	2	2	2
Have knowledge of environmental issues	I	1	2	3	2
	II	2	3	3	2
Know ways and possibilities to solve environmental issues	I	2	2	2	2
	II	3	2	2	3

The level of all the participants' knowledge according to the indicators of environmental concepts and knowledge how much time is needed for different waste to decompose rises by at least one level. The level of all the participants' knowledge about waste decomposition time prior to the educational experiment is low or very low, and it reaches average level after the experiment. The change is visible, yet the highest level is not reached. It is difficult for the study participants to remember the decomposition time of different materials even after the animation and interactive tasks.

After the educational experiment, T2 and T4 are not able to define the concept of natural resources even though the animation talked about it.

6.2. Assessment of the third-graders' environmental literacy according to the level of their environmental awareness

Assessment of third graders' level of environmental awareness is shown in Table 02.

Table 02. Assessment of study participants' level of environmental literacy

Indicators	Before (I), after (II) the experiment	Study participants			
		T1	T2	T3	T4
Is aware of the factors contributing to environment pollution and sustainability	I	3	2	3	3
	II	3	3	4	3
Is aware of the importance of environment protection for people, nature and animals	I	2	2	3	3
	II	2	3	3	3
Is aware of different waste decomposition time	I	0	0	2	1
	II	2	2	2	3
Demonstrates environmental values and attitude	I	2	1	3	2
	II	3	2	3	2

The criterion of the assessment of environmental awareness consists of the following indicators: perception of actions contributing to environment pollution and sustainability; perception of the importance of environment protection to people, nature and animals; perception of the time needed for different waste materials to decompose; and demonstration of environmental values and attitude. The indicator of demonstration of environmental values and attitude is tested considering the participants' statements that show their wish to reduce air and water pollution, desire for the nature to be beautiful and clean. Perception is assessed according to the way the subjects interpret, recognise, summarise and explain information, what attitude and values they demonstrate.

The data are quite varied. After the educational experiment, participant T1 demonstrates high level of awareness, yet she still does not understand why filling the sink with soapy water for dish washing is better than do the dishes under the running water.

Research participant T2 is more confident in her answers after the experiment. Her answers are much more thorough (*The picture with a pile of laundry. Because it is not effective to wash two clothes and use up a lot of water.* T2). She starts using more environmental concepts (*light energy*), perceives the damage of littering better and is able to explain the reason for waste sorting. On the other hand, she chooses the

wrong answer that it is better to drive a car alone, which sounds unsure and in a questioning tone (*The one who is driving alone?* T2).

After the experiment, research participants T3 and T4 are for efficient use of water, reduction of air pollution and littering. Besides, subject T4 supports waste sorting, “*Yes. Lithuania won’t be beautiful. This is not from the cartoon, but because it is so*” (T4). Considering all her answers, the biggest change in the level of awareness (from low to very high) is seen in the perception of time needed for different waste materials to decompose.

6.3. Assessment of environmental literacy according to the third-graders’ level of environmental skills

Assessment of the third-graders’ level of environmental skills is presented in Table 03.

Table 03. Assessment of the participants’ level of environmental literacy skills

Indicators	Before (I), after (II) the experiment	Study participants			
		T1	T2	T3	T4
Environmental action planning skills	I	2	2	2	2
	II	3	2	3	3
Skills of critical evaluation of information	I	1	2	3	2
	II	1	2	3	3
Environmental problem solving skills	I	2	2	2	2
	II	3	3	3	3

As it is seen in Table 03, all the participants’ answers in terms of environmental action planning skills are evaluated as being average prior to the educational experiment. After the experiment, the three subjects’ (T1, T3, T4) level goes up at least one level. Each of these subjects is able to indicate at least two actions that help reduce the amount of household waste. T2 indicates one strategic action both times (before and after the experiment). The examples of their answers are as follows:

Before the experiment: *Hmmm, maybe... maybe if I brought some waste material, for example, egg containers, we could make something during craft lessons.* (T1)

After the experiment: *So first of all I would bring some waste material for crafting from home. I would not buy so many things, thus I wouldn’t need to throw away so much garbage.* (T1)

Interactive animation shown during the educational experiment has no substantial impact on the participants’ skills to critically assess information. Only one subject (T4) experiences change in the level of her skill to critically assess information. She demonstrates with her answer that she is not sure the information presented in the animation is correct: “*Probably yes*” (T4). The word probably gives away her uncertainty, which in this context functions as a feature of critical assessment of information, i.e. not to trust information until it is verified.

Table 03 shows that change in all the participants’ level of environmental problem solving skills. The examples of their responses to the question “What would you do if you saw other people littering?” are the following:

Before the experiment: *Well, I would say nothing to the person. I wouldn’t say to anyone.* (T3).

After the experiment: (silence) *well, maybe I would say something after the cartoon gal* (T3) (however, the investigator notes doubting intonation).

The most significant change is noticed in all the participants' skills to solve environmental problems. The fourth subject's (T4) level of environmental skills changes in all the three spheres. Change in the level of T2's environmental skills is observed only in relation to one indicator (environmental problem solving skills). T3 and T1 demonstrate change in the level of their skills according to two indicators of environmental skills.

It would be complicated to achieve the efficient educational process using high-level interactive animation because of two reasons. First, students may tend to surface watch the content. Second, the students may be too much captured by the content, which would interfere with their ability to process the entire material since the programme poses too high cognitive challenges and requirements (Lowe, 2003).

The performed educational experiment have studied the participants' environmental knowledge, environmental awareness and environmental skills. Environmental actions are not investigated as the chosen instrument for the educational experiment is not suitable for measuring any change in environmental actions. However, the results of other studies (Toledo, 2015) show that environmental knowledge and awareness of environmental issues are not enough to ensure environmental actions. Thus, further empirical investigations in this direction would deal with correlation between interactive animation for the development of environmental literacy and participants' environmental actions. Moreover, a further research could also include comparing efficiency of interactive animation for the development of environmental literacy with other methods of developing environmental literacy, expanding the sample of the study, prolonging the period of educational impact, etc.

7. Conclusion

The empirical study revealed the following possibilities and limitations of using interactive animation in developing environmental literacy in primary school pupils: interactive animation is a suitable method to develop pupils' knowledge of environmental concepts, knowledge of environmental issues and the ways to solve them. Interactive animation with interactive tasks does not help the subjects acquire exact information, yet improve their environmental awareness and skills at the solution of environmental problems. Too low or too high level of interactivity in interactive animation distracts a learner and causes boredom, which interferes with the educational goals.

To develop the environmental literacy of primary school pupils, it is recommended to use the digital learning programme "Smart Robots" and the interactive animations "How to separate waste" and "Efficient use of natural resources" with additional tasks that the programme includes.

We could recommend the creators of interactive animations for the development of environmental literacy to seek coherence in the content and form of interactive animation, take into consideration peculiarities of the cognitive development of primary school pupils, include specific examples, make sure that the content and form are acceptable and clear to pupils, choose the level of interactivity that would help keep learners' attention and would be relevant in terms of efficient educational impact on primary school pupils.

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