AATISH SINGH

# NUCLEAR TOURISM

## EDUCATIONAL POTENTIAL OF THE INDUSTRIAL HERITAGE

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# Nuclear Tourism: Educational Potential of the Industrial Heritage

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Aatish Singh

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Nuclear Tourism: Educational Potential of the Industrial Heritage
Aatish Singh
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Judita Kasperiūnienė

# Innovative Technological Solutions in Virtual Nuclear Education

**Abstract:** The need for researching nuclear learning-related processes in different countries, formal and non-formal education contexts and age groups, has been continuously growing. The plethora of didactic and technological solutions to create virtual nuclear education products often misleads educators. Our study aims to categorize and map out the existing scholarly concepts and online examples of nuclear education and virtual tours, from which to commission further reviews by identifying gaps in the research literature and virtual solutions. The findings from the review of the articles accessed in Springer Link, Scopus, Taylor & Francis, and ACM mono and multidisciplinary scholar databases and online portals, apps, and games on nuclear learning–related topics showed the difference in the concepts on nuclear education, nuclear information, and nuclear technologies for diverse scientific fields. Literature analysis has revealed a gap between modern technologies and methods of teaching and learning in formal and non-formal education contexts. Research showed that the integration of technological progress into teaching processes could be challenging. Mature educational technologies and methods may not adequately address the needs of individual learners and society. The findings, illustrating the complex nature of virtual reality solutions and virtual tour technologies applicable to online nuclear education, nuclear information, and nuclear technology studies, covering topics of empirical scholar research, online and smart solutions, allowed us to construct a framework of serious gaming for non-edutainment purposes, incorporating learning and playing tools, motivators, and educational strategies.

Our research gives insights into nuclear tourism route construction, proposing a technology acceptance model, suggesting storytelling, virtual navigation, human spatial behavior, digital and human factors, and tools and technologies research as the key topics of further empirical research and offering online tours, mobile apps, and 360 videos as technologies to facilitate virtual learning, impact learning outcomes, and raise nuclear literacy. While proposing to use serious games and tours for virtual nuclear education, we see some limitations. In nuclear education settings (formal and informal), these technologies are mainly adapted to the learner generation who accept technology. Still, some learners find it difficult to immerse in virtual activities and experience a difference between virtual and live guided tours. For educators, the biggest challenge is not only to create virtual materials on nuclear education in the text format but also, together with computer scientists and engineers, to develop virtual narrative, immersive games, simulation apps, and other types of virtual reality solutions. For nuclear scientists, the biggest challenge remains the communication of scientific information in a learner-friendly format.

**Keywords:** educational tools for virtual tour development, experiential gaming, geolocation technologies for education, mapping review, serious gaming for non-edutainment purposes, technology acceptance model, virtual nuclear education.

## Introduction

Nuclear science is the study of atom application to various spheres of human life. It not only deals with structures, elements and forces of the nuclei; application of radioactive substances in the diagnosis and treatment of various diseases; sub-atomic processes in technology or chemical engineering, but also with nuclear safety and security; climate change; and policies, countries, and communities. Nuclear science can be studied in formal and informal nuclear education settings. Formal *nuclear education* starts in pre-primary classes and continues in schools, universities or colleges. Children start nuclear education in kindergarten through environmental lessons. Later, integrated STEM lessons develop students' *nuclear literacy* – the ability to recognize, understand, interpret, create, communicate, calculate, and use printed and written data about the atom, its properties, and applications in a variety of contexts and real-life situations. A few examples below show that in the formal education context, nuclear (or atomic) literacy is developed in a comprehensive way, integrating it into a variety of study curriculums, subjects, classes, and informal education. For example, in Hungary, "nuclear chapters of the curriculum" were integrated into school education in the last decade of the twentieth century (Toth & Marx, 1996) after the Chernobyl catastrophe. While these lessons teach atomic physics, chemistry or nature, teachers say their students are learning to observe everyday life; they learn democracy and decision-making based upon a shared understanding of information. In addition to that, students learn that nuclear education means responsibility for others and for the future (ibid.). In post-Fukushima Japan, scholars, teachers, and decision-makers believe that nuclear education (formal and informal) is very important, and the subject is actively discussed. For example, radiation lectures are provided in Japanese high schools, seeking that nuclear literacy positively transforms learners' attitudes and behaviors related to radiation in general, and disasters specifically (Tsubokura, Kitamura & Yoshida, 2018). Japanese scholars have proved that nuclear education enables young people to make better decisions about important matters in their daily lives. Another study in Turkey (Yavuz-Topaloglu, Demirhan, & Atabek-Yigit, 2019) focused on the importance of gender in examining the links between nuclear education and daily living. The results

of this study showed that male respondents support nuclear power more than female, and adult females with children (mothers) are more likely to oppose nuclear power. These findings are even more important because the family in general and mothers in specific have a great influence on their children not only in formal, but also in informal education.

In the higher education context, *nuclear technology studies* are more specialized. They are mainly concentrated in fundamental, medicine or engineering faculties of universities and colleges. Although nuclear science is a relatively young science and several incidents all around the world have attracted public opinion, the interest of the young generation in the formal nuclear study has fallen (Brancucci, Flore, & von Estorff, 2014). Engineering faculties have reduced student admissions to nuclear education–related study programs (Ahn et al., 2015). Meanwhile, the first generation of nuclear experts and professionals have begun to retire, resulting in a gap between the incoming and outgoing specialists' flows (Brancucci, Flore, & von Estorff, 2014). This has led not only to a gradual shortage of skilled professionals and a greater risk of losing valuable knowledge to the nuclear community (ibid.) but also to the deteriorating public awareness of nuclear education and nuclear safety–related issues.

Informal nuclear education is a very important topic that encourages people of all ages to think, make decisions, and understand the importance of nuclear energy not only in engineering or medicine but also in everyday life. (Luk et al., 2018). Informal nuclear education happens in education laboratories, museums, exhibitions, non-formal places, and virtual spaces. In order to enhance the children's, teachers' and the community's interest in modern nuclear physics or nuclear energy, scientists search for non-traditional ways, places, environments for teaching and organizing active or immersive learning. New emerging technologies, such as virtual and augmented reality, computational dynamics, virtual laboratories, and virtual worlds have recently been more widely used not only for teaching Science, Technology, and Engineering, but also for informal science education and science communication. Virtual reality, characterized by three key elements, such as *visualization,* when the user, gamer, or learner has the ability to look around, usually with the use of a head-mounted display; *immersion,* when the person mixes imaginary and physical representation of objects; and *interactivity,* providing the degree of control over the experience, usually achieved with sensors and an input device like joysticks or keyboards (Yung & Khoo-Lattimore, 2019), is taking an increasing place in teaching and learning. The concept of immersive education can be applied to all aspects of education for different age and competency group learners: formal, informal, massive and professional training, from preschool education to

life-long learning (Potkonjak et al., 2016). One of the most popular contemporary educational environments is virtual or mixed reality tours (Domingo and Bradley, 2018). Virtual tours are panoramic, virtual, augmented, or mixed reality simulations of the existing rural or urban places and environments. Technically speaking, virtual tools are collections of images accompanied by sounds or audio texts. Virtual tour development technologies have been thoroughly analyzed and described; they are constantly changing and improving (e.g. Napolitano, Scherer, & Glisic, 2018; Yung & Khoo-Lattimore, 2019; Tung et al., 2015). The educational goal of virtual tours and their relation to audiences determine not only how the virtual tour is constructed, accessible or immersive, but also what didactic messages are sent to users.

In addition to formal and informal nuclear education, *nuclear information* (informing, sharing and raising awareness of nuclei-related topics) may generate support for scientific research and technological practices; influence decision-making; inspire political, ethical and environmental thinking; and educate and strengthen communities.

In Lithuania, despite the fact that the country is no longer considered a nuclear state as the Ignalina Nuclear Power Plant was shut down more than a decade ago, public nuclear literacy for different education groups remains particularly important. By synthesizing and analyzing the existing scientific literature and online technological solutions on nuclear education and virtual tours and integrating research from various subjects (not limited to nuclear physics and environmental education, science, engineering and computer technologies), insights for the nuclear virtual route development can be created. The *aim* of this study was to categorize and map out the existing scholar concepts and online examples of nuclear education from which to commission further reviews by identifying gaps in the research literature and virtual solutions for educational material presentation. The *research question*s were: (i) how the concept of nuclear learning is presented and discussed in research literature; (ii) what topics of empirical research related to nuclear education through virtual tours dominate in scientific databases of multidisciplinary and monodisciplinary peer-reviewed literature; (iii) what topics, scenarios, and solutions are used to create freely accessible virtual tours to develop nuclear literacy.

## Methodology

The mapping review (Grant & Booth, 2009) was applied to search and contextualize the research literature and internet portals that provide the possibility to

travel and learn virtually. Systematic review search filters were used by summarizing empirical research articles related to nuclear education, searching information about virtual tours development and their use in teaching and learning process, focusing on the first research question (Lefebvre et al., 2017).

In the mapping review, the principles of scientific evidence-based inquiry were followed: (i) opening significant questions for empirical investigation of scientific literature and website materials; (ii) linking research to conceptual framework; (iii) using causal mapping as a method and technique (e.g. Lorenc et al., 2012; Bryson et al., 2004) that allowed direct investigation of the research question; (iv) mapping chain of reasoning (Lal, Donnelly & Shin, 2015), identifying limitations and biases, and estimating uncertainty (McMillan & Schumacher, 2010).

The mapping review was conducted in Scopus, ACM, Springer Link, and Taylor & Francis databases (2014–2018). These databases were selected seeking to find and analyze mono and multidisciplinary empirical research in social and technological sciences with a STEM perspective. The iterative stages of searching, synthesis, critical interpretation, and causal mapping were performed while researching nuclear education and science communication–related scholar topics and technological solutions of virtual tours. The following inclusion criteria were used: (i) the full article was published in scientific peer-reviewed journals in English; (ii) the article was published between 2014 and 2018; and (iii) the articles were based on an integrated approach covering nuclear education and virtual tours with the focus on STEM with a strong emphasis on citation of the selected articles. In the selection of empirical articles, preference was given to those who influenced the creation of new meta-theoretical constructs seeking theoretical saturation with respect to the framework. If the articles contained contradictory, conflicting, or underdetermined theories, the search continued seeking to purify those empirical studies, in which the variables of the chosen theory associated, correlated or reported the empirical data, making connections and preliminary substantiating theoretical statements or claims (Lorenc et al., 2012).

The construction of the research consisted of three stages inside the general iterative mapping review procedure. In the initial phase, scientific literature was identified, screened, and structured using the keywords "nuclear education" and "virtual tours", finding the key topics of empirical research. During the second phase, the ten most popular online freely accessible virtual tours were investigated and tested. Then the links between the concepts, empirical research topics, virtual tour scenarios, and technological solutions were developed, and challenges discussed.

## Findings

A variety of technologies exists to provide and support virtual nuclear education. Our research focuses on *game-based learning* (e.g. Romero et al., 2016) as the method of teaching with games not specifically for virtual nuclear education. Game-based learning allows users of all ages and backgrounds to stay motivated and self-master the study curriculum effortlessly. Different types of games continuously motivate players with elements of challenge, fantasy, and curiosity (e.g. Asgari & Kaufman, 2004; Malone, 1980). While the main "official" goal of games is entertainment, scholars discuss the use of games in different learning environments and disagree over whether players learn while they are having fun. We consider that higher levels of thinking and social skills can be developed through play and learning. Creating and mastering the content means gaining facts, information and skills, and building knowledge not only from teachers, practitioners, and other experts, but also from the game environment and other gamers. Many games where users need to master their own content offer opportunities for individual or group learning. These types of games could be applied not only to informal studies, but also to formal education classrooms as additional learning materials to stimulate learner interest and to raise study motivation. Games can develop cognitive and perceptual competencies such as attention and concentration on details, characters or events; understanding of story-play, strategic thinking, problem-solving, planning, and memorizing. Games sharpen players' emotional and volitional competencies such as emotional and stress control, and endurance – the skills, critically important for social development, as well as academic performance and later life success (e.g. Hromek & Roffey, 2009). School children experiments by Goldstein and Lerner (2018) proved that in games, children could develop altruism to a stranger; comforting behaviors to someone in distress; helping behaviors to a person who needs assistance; and positive classroom social behaviors. Additionally, players develop cooperation, competition, mutual support, empathy, and moral judgment competences (Wiemeyer & Hardy, 2013).

Further in this chapter we discuss some issues concerning *serious games* – the digital games used for non-entertainment purposes not specifically in nuclear education environments. The research of empirical evidence of the impacts and outcomes of serious games, performed by Boyle and her colleagues (2016), has pointed out that the term "serious games" is becoming a new mainstream. In many cases, it is used interchangeably with *games for learning*. Serious games can be used to promote knowledge acquisition across a wide range of topics, to develop social skills and behavior change. For formal and informal nuclear

education, an experiential gaming model (Kiili, 2005), based on *experiential learning theory* (Moon, 2013), flow theory (Nakamura & Csikszentmihaly, 2009) and game design (Salen, Tekinbaş & Zimmerman, 2004) can be used. In experiential learning theory, learning is described as a cycle integrating "Dewey's philosophical pragmatism, Lewin's social psychology, and Piaget's cognitive developmental genetic epistemology" (Kolb & Kolb, 2012, p. 2), and transforming active experiences into conceptual understandings and applications through reflection (Moseley et al.,2020). The four-stage cycle is observed: active experimentation, concrete experiences, reflective observation, and abstract conceptualization. Although learning could begin at any stage, all the stages need to be completed – introducing active experiencing with new concepts, models, role-playing and problem-solving, discussing, analyzing, and reflecting on live or virtual experiences (ibid.). The learner can become so involved in the game that he no longer feels the amount of time he has been playing. Time is like "disappearing" (Nakamura & Csikszentmihaly, 2009). Therefore, to keep the user not only entertained while playing, but also achieving educational goals, game developers need to collaborate with educators on the game design. *Technology acceptance model* (e.g. Marangunić & Granić, 2015) explains how learners accept and use technologies, analyzes the learners' intentions, attitudes, motivation, and beliefs concerning technologies. Game-based learning used for education scenario and game environment development consider gameplay and usability perspectives; learner technological competences and preferences; edutainment experiences; and pedagogical integration. (Fig. 1).

*A virtual tour* is a simulation of an existing location with the help of audio, outdoor and indoor maps, floor plans, sequential videos, or still images. These tours help in recreating a realistic representation of reality and presenting views to inaccessible areas. In nuclear education, there are some areas of the nuclear power plant restricted to non-specialist visit, or some specific situations need to be artificially constructed for information or education; therefore, virtual tours could be a solution for a broader audience. Besides, virtual tours could become an interesting alternative to fieldwork when expenses, time, or logistics are an issue for users. Nuclear education and science communication could develop not only through serious gaming techniques, but also by applying *virtual tours* as innovative and interactive tools, as well as presentations of learning materials and new knowledge, allowing users to actively immerse into a topic. In many cases, virtual tours, similar to the so-called live tours and excursions, are guided. Guiding allows the user not to be lost on a tour. *Digital guiding* could be done by using text, pictures, maps, audio, video materials, or a combination of these techniques. It includes serious game elements that motivate learners


**Fig. 1:** The framework of serious gaming for non-edutainment purposes

and makes the overall process not only challenging, but also entertaining and immersive. Quite frequently, a person sitting in front of a computer does not even distinguish between virtual tours and digital games. Guidance features, the availability of feedback and performance reporting, and the integration of engaging and reflective capabilities enhance the overall experience, empower the learner's memories, help to interact with new knowledge, and develop practical skills (Mostafa, 2018). Through the virtual guided tours, learning, and raising awareness on nuclear tourism, the route could grow. With the help of serious games and virtual tour tools, learners are informed about science and get involved in continuous learning. During the virtual tour, they are allowed to experiment, observe, and change their environmental habits. Therefore, as with serious games, people of all ages acquire knowledge, new skills, learn how to creatively solve problems, actively experiment, reflect and observe, and conceptualize their own findings (Fig. 2).

In the next section, the research topics of the last five years (2014–2018) dominating in the empirical scientific articles in the area of nuclear education and virtual touring are identified and key themes discussed.

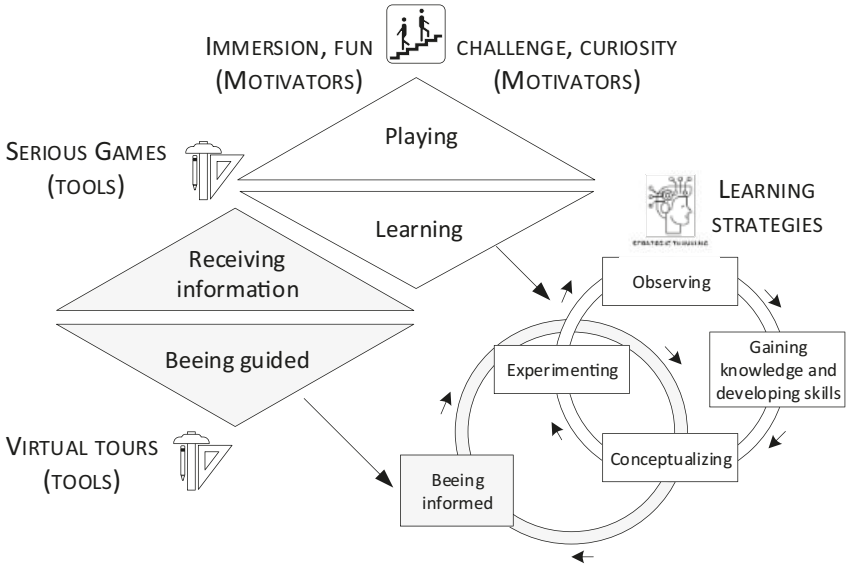


**Fig. 2:** Experiential gaming tools, motivators, and learning strategies for virtual nuclear education

## Dominating Topics of Virtual Nuclear Education Empirical Research

In four scholar databases, 1268 empirical articles were screened (N=1268), using three main keywords: "nuclear education", "virtual tour technologies", and "virtual reality solutions". The database search exposed that articles empirically studying *nuclear education* concept are mostly published in Springer Link (n=682, 53.7 % of all researched cases) and Scopus (n=354, 27.92 % of all researched cases). In Taylor & Francis database 165 articles (n=165, 13.01 % of all researched cases) and in ACM – 67 articles (n=67, 5.28 % of all researched cases) have been found.

In Springer Link, the most popular concept was *virtual tour* (634 articles), while the *nuclear education* concept was much less popular (48 articles). In this database, *computer science* (230 articles) and *engineering* (74 articles)–related topics dominated (Fig. 2). Empirical studies on virtual tours covered technological peculiarities of user interface construction and human-computer interaction testing in artificially created environments (e.g. Zhang & Zhu, 2017; Checa, Alaguero & Bustillo, 2017); information systems application for indoor and

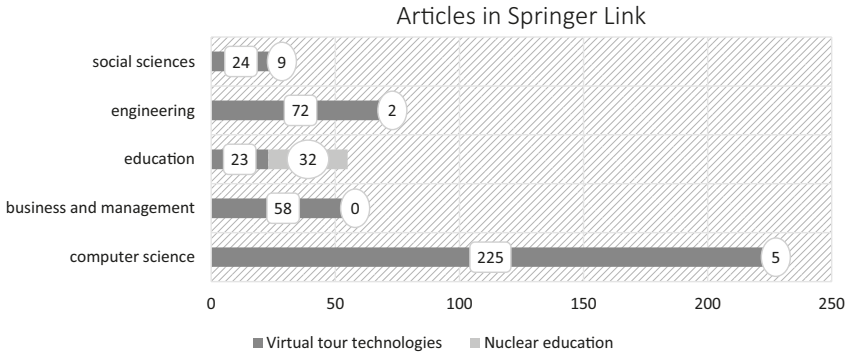


**Fig. 3:** The number of articles from the five most popular scientific fields researching nuclear education and virtual tours in *Springer Link* online collection of scientific, technological and medical journals, books and reference works (N=634; the number of articles researching virtual tours in the rectangle; the number of articles researching nuclear education in the oval)

outdoor museum exhibitions (e.g. Fabrizio, Chara & Brumana, 2018; Kersten, 2018), immersive web-based, panoramic, virtual, and augmented reality tours (e.g. Debailleux, Hismans & Duroisin, 2018; Bruno et al., 2016), VR games (e.g. Zhang et al., 2018; Iacono, Zolezzi & Vercelli, 2018), storytelling (e.g. Carrozzino et al., 2018; Battad & Si, 2016), etc. (Fig. 3).

In Scopus, empirical articles on *virtual reality solutions* and *virtual tour technologies* were the most popular (Fig. 4). The tourism computerization process, design of virtual tourist routes (e.g. Voronkova, 2018; Bruno et al., 2017); 3D and augmented guided tours and excursions (e.g. Lee, 2017), virtual and GPS-based navigation solutions (e.g. Wang & Chen, 2018), virtual and mobile museums, exhibitions, nature and cultural heritage, historical and wildlife preservations (e.g. Podzharaya & Sochenkova, 2018; Kersten et al., 2018), computer graphics, data visualization, 3D restorations of heritage objects (e.g. Cha et al., 2018; Castagnetti, Giannini & Rivola, 2017) were empirically researched in outdoor and outdoor educational environments, formal and non-formal learning settings. A total 65 articles empirically examined *nuclear education* and *atom engineering*–related topics. These topics covered nuclear literacy, nuclear information, and nuclear technology education. Luk et al. (2018) presented immersive virtual reality systems for nuclear literacy. Some empirical research focused on nuclear safety and raising public awareness (e.g. Wang

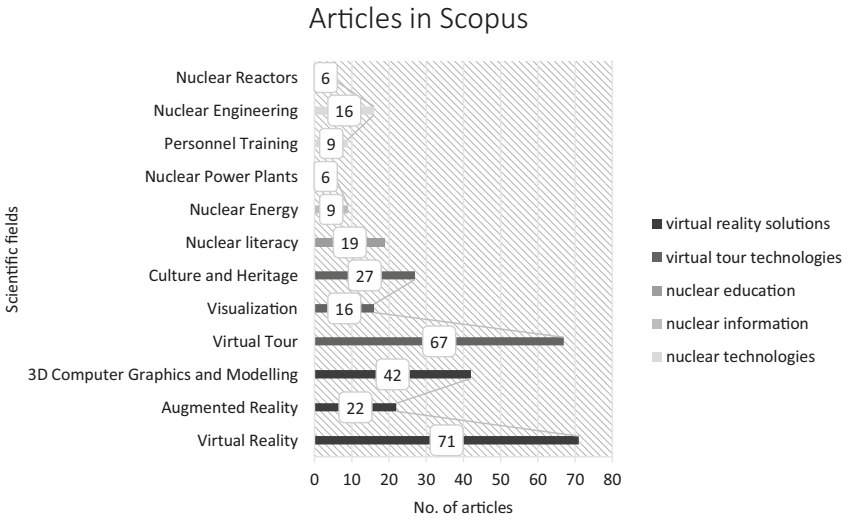


**Fig. 4:** Most popular article topics, researching virtual reality solutions, virtual tours and formal and informal nuclear education and training in *Scopus* peer-reviewed journals (N=372)

et al., 2017; Liu & Xia, 2014) and virtual laboratories and simulators for nuclear power plant specialist training (e.g. Yakovlev et al., 2015; Gatto et al., 2013). The authors stated that immersive learning could grab learners' attention, build an interactive educational relationship, develop a sense of belonging to nature and community, and activate life-long learning action.

In Taylor & Francis, 25 empirical articles researching *nuclear education* were found (Fig. 5). Here, studies on nuclear (atomic) literacy were published (e.g. Carson, 2018; Volpe & Kühn, 2017). The studies on virtual tours examined tours as educational phenomena. Orru, Kask and Nordlund (2019) empirically investigated social and individual motivational factors governing satisfaction with virtual nature touristic routes. These authors confirmed that a good foundation story and educational narrative may expand enthusiastic reactions and emotional responses. Virtual field trips as a technique for experiential learning in school were studied by Kenna and Potter (2018). These researchers discussed the benefits and limitations of virtual field trips to students and presented different cases of virtual field trips, stating that virtual tours are "the most viable means of accessing the world outside the classroom to incorporate experiential and authentic activities into the daily curriculum" (ibid.).

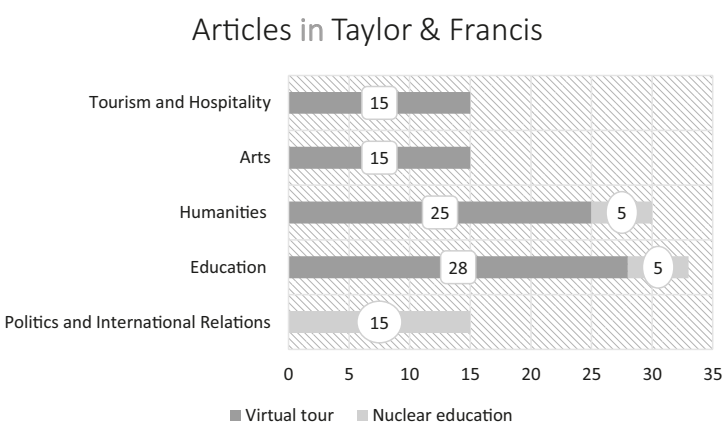


**Fig. 5:** Most popular article topics on a virtual tour and nuclear education-related topics in *Taylor & Francis* books and academic journals (N=165, number of articles researching virtual tours in the rectangle; the number of articles researching nuclear education in the oval)

The ACM Digital Library is the world's most exhaustive database of scholar publications and bibliographic materials covering computing and information technology. In this database, empirical articles that investigate the atomic instruction idea were not found. The most popular topics covering the virtual tour conceptual area are presented in Fig. 6. In the empirical articles, provided in the ACM database, virtual reality software and technology and virtual tutoring environments were comprehensively researched. Software and hardware systems for virtual navigation, such as 3D virtual scene generation (e.g. Wang & Chen, 2018), artificial agents as tutors (e.g. Cafaro, Vilhjálmsson, & Bickmore, 2016), and many more modern information technology–related topics, repeated in the previously mentioned databases, were contemplated. In the articles published in ACM journals, non-natural landscapes, embodiment, relational intelligence, human-like appearance, and non-verbal behavior were analyzed in artificially created environments.

The literature screening revealed three additional conceptual areas directly linked to *nuclear education* and *virtual tours* with the focus on STEM and virtual environments – (*Nuclear) Serious Games*, *Digital Guiding* and *Nuclear Tourism Routes*. Nuclear serious games are electronic games that have the purpose to educate, train, and change the learner's behavior through entertainment in the areas of nuclear literacy, atom physics, environmental security or related

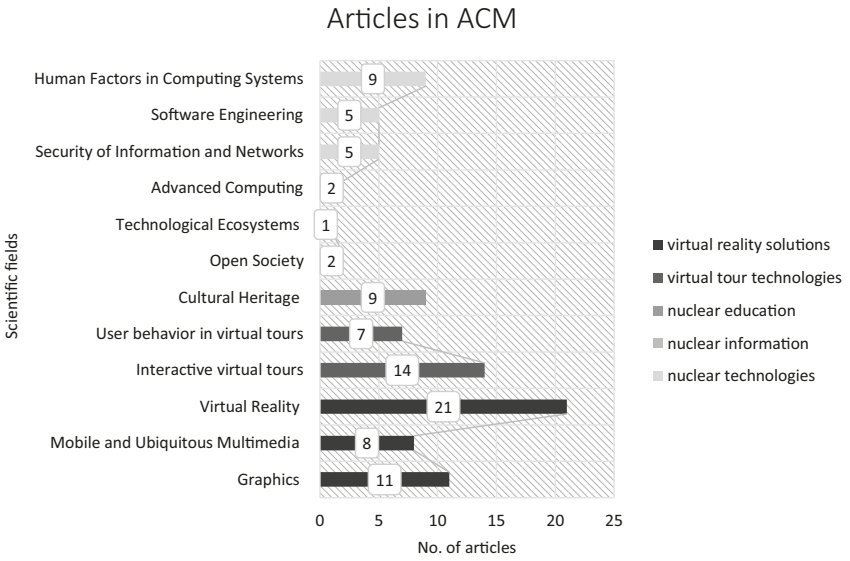


**Fig. 6:** Most popular article topics, researching virtual reality solutions, virtual tours and formal and informal nuclear education and training in *ACM* digital library (N=67)

subject areas by applying various problem solving, challenges, rewards, and other engagement components provided in virtual gameplay environments. Technically speaking, serious games could be computer or mobile games, simulations or interactive models, virtual environments, augmented or mixed reality and social media meeting places that provide opportunities to educate or train through responsive narrative and story, gameplay and encounters. Digital guiding is an educational activity aimed at virtually transmitting information about original objects, cultural and natural resources, constructing subjective meanings and establishing an experiential relationship, and instilling understanding and appreciation of the interpreted environment. Technically, digital guiding is done with audio or video technologies, text, or interactive communication. The nuclear tourism route is a virtual walk on specially selected areas important to nuclear energy. The learner usually constructs the nuclear tourism route himself or herself of freely chosen virtual paths, scenes, or game environments with known social, topographical, or economic accents – including images, recreation areas, and interpretive regions that reveal certain features and aspirations for nuclear literacy. In the studied scientific articles,

nuclear museum education was touched very superficially. Supposedly, it is under investigation, but in this context, virtual solutions integration and game-based learning have not been sufficiently explored. Links between empirically researched conceptual areas based on researched concepts, most popular scientific fields observed in multidisciplinary and monodisciplinary peer-reviewed articles, and teaching, training, and learning challenges are presented in Tab. 1 and Tab. 2. Substantial challenges are related to the use of smart technology and the relative reluctance or inability of experts to communicate scientific knowledge in a way that is understandable to the public. For example, as modern technology solutions are constantly evolving, formal education institutions and individual learners often do not have access to the latest virtual reality devices. In addition, some specialized software is expensive.

## Educational Gaming to Explore and Analyze Real-Life Issues

A variety of educational text-based materials, virtual games, and apps exist online for raising nuclear awareness and atom literacy. For example, ANSTO – one of Australia's largest public research organizations, internationally recognized players in the field of nuclear science and technology – runs a portal for business, education, and public science (ANSTO, 2019). The portal operates in the English language, thus making it accessible not only to the local reader, but also to the international audience. This portal contains general facts about nuclear science, radiation, radioisotopes, synchrotron light, and managing waste. In ANSTO, nuclear energy experts and professionals create and share educational materials. The educational and informational texts are specially adapted to different target groups: primary, secondary, tertiary education, and materials for teachers. For primary school children, ANSTO offers nuclear competitions such as *Shorebirds in Botany Bay* (raising awareness of the plight of endangered shorebirds in specific territories and local habitats that are important for shorebirds and other organisms) or *Top Coder* (mobile technology, coding, computer programming, and robotics in collaboratively environments). These educational activities stimulate thinking, develop a creative personality, and shape passionate involvement in problem-solving. For primary school children, educational activities are live and are only advertised online in ANSTO portal. For the secondary school children, workbooks and datasets are provided. These workbooks and datasets can be used in formal classes of science, chemistry, physics, or biology. Additionally, electronic workbooks can serve as required learning materials accompanying

**Tab. 1:** The challenges in virtual technology solutions and virtual tour technologies used within most popular scientific fields and educational settings

| **Concepts** | **Scientific fields** | | | | **Challenges** | **Sample** |
|---|---|---|---|---|---|---|
| | **Springer Link** | **Scopus** | **Taylor & Francis** | **ACM** | | **research** |
| Virtual reality solutions | | *Virtual reality*, 3D computer graphics, and modeling augmented reality | | *Virtual reality*, graphics, mobile and ubiquitous multimedia | i) Although technology offers unique simulation and visualization opportunities for use in everyday life situations, urban and environmental planning; could teach a healthy lifestyle; healthier and safer living, the biggest challenge stays technology acceptance.<br>ii) Immersion in technology activities may become unmanageable and hard to self-regulate. | Luk et al., 2018; Checa, Alaguero & Bustillo, 2017; Zhang & Zhu, 2017; Boulos et al., 2017 |

(*continued on next page*)

**Tab. 1:** Continued

| Concepts | Scientific fields | | | | Challenges | Sample |
|---|---|---|---|---|---|---|
| Virtual tour technologies | Computer science, engineering, business and management, social sciences (general), education | Virtual tour, culture and heritage, visualization | Education, humanities, arts, tourism, and hospitality | Interactive virtual tour, user behavior in virtual tours | i) Users are engaged in complex problem solving that requires coordination of multiple concepts to define (effective) solutions.<br>ii) The tools and technologies such as virtual helmets, glasses, and smart devices could be too expensive for the individual user. | Debailleux, Hismans & Duroisin; 2018; Castagnetti, Giannini & Rivola, 2017; Battad & Si, 2016; Bruno et al., 2016; Bohlin & Brandt, 2014; Neuhofer, Buhalis & Ladkin, 2014 |

**Tab. 2:** The challenges in nuclear education, nuclear information, and nuclear technologies used within most popular scientific fields and educational settings

| Concepts | Scientific fields | | | | Challenges | Sample |
|---|---|---|---|---|---|---|
| | Springer Link | Scopus | Taylor & Francis | ACM | | research |
| Nuclear education | *Education*, computer science | Nuclear literacy | Politics and international relations, *education*, humanities | Culture heritage | The gap between technology and learning methods: difficult integration of technological advances into teaching; a | Volpe & Kühn, 2017; Nakamura, 2016; Ahn et al., 2015; Liu & Xia, 2014 |
| Nuclear information | | Nuclear energy, nuclear power plants | | An open society, technological ecosystems | danger that mature educational technologies and methods might not give an adequate answer to the demands and needs of society.i) | Tsubokura, Kitamura & Yoshida, 2018; Carson, 2018; Wang et al., 2017; Nakamura, 2016; García-Peñalvo et al., 2015; Ahn et al., 2015 |
| Nuclear technologies | | Nuclear engineering, personnel training, nuclear reactors, waste repositories | | Human factors in computing systems, the security of information and networks, software engineering, advanced computing | Lack of information and initial knowledge to understand complex nuclear solutions. | Gan & Yang, 2017; Salmani-Ghabeshi et al., 2016; Ramchurn et al., 2016 |

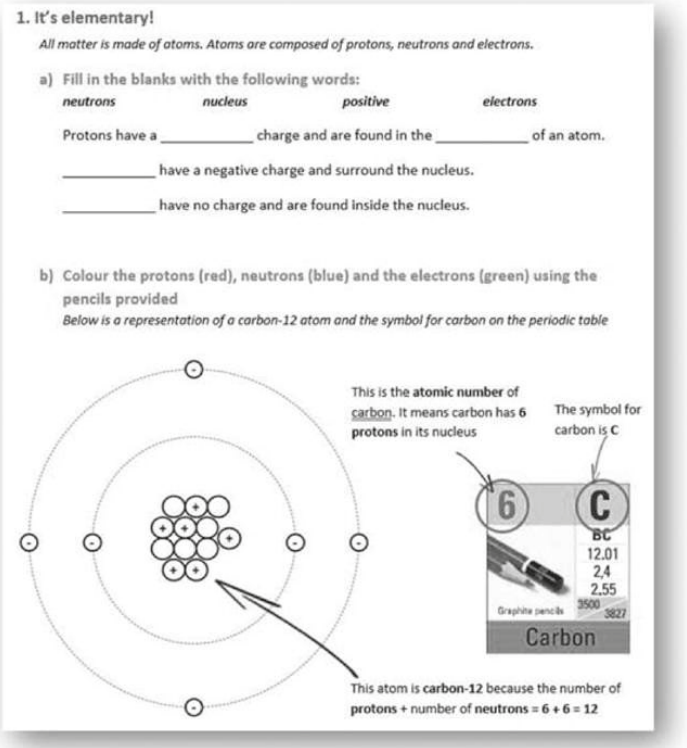


**Fig. 7:** An example of hands-on nuclear science workbook for secondary school children (7 to 10 years old), which could be used during a live class excursion to ANSTO (extracted from ANSTO files, 2019)

a live school excursion to the laboratories of Australia's Nuclear Science and Technology Organization. The workbooks are freely downloadable online. The exercises in the workbooks are divided into topics. Standard question types are used, such as calculated simple and multichoice, essay, description, typing, matching, gap-fill, and others. An example of the workbook is presented in Fig. 7.

In addition to workbooks and datasets, secondary school children and their teachers can virtually meet nuclear experts and participate in video-conferencing sessions. During these sessions, students plan and investigate

their first physical or chemical experiments. Virtual access to high-quality radioactive sources, instruments, and scientific expertise are provided. Videoconferences last 45 minutes (a traditional lecture time) and need to be ordered in advance. During virtual sessions, students can ask questions, discuss their nuclear education-related experiments and receive expert feedback. A piece of special equipment for measuring and detection, radioactive sources and objects, and radiation shielding or similar tools are needed for experimenting. The practical training can only be done live in class under the teacher's or instructor's supervision. For tertiary education, early carrier programs are provided. Furthermore, ANSTO offers different virtual reality, mobile and online games, and apps to discover the world of nuclear science. For example, children can explore how much radioactivity it is possible to absorb in daily life, learn about health protection, the periodic table, and the atom building.

Dalton Nuclear Institute at the University of Manchester virtually shares tools, games, and information sources about nuclear energy. In their case, the educational materials are created by the University scientists and their students. Some of the tools, such as *Energy card games* or *Nuclear energy paper fortune tellers*, are offline. Others, such as *Nuclear Reactor Simulator*, are available online.

High tech educational applications, such as dynamic modeling, simulation, and 3D visualizations, are available to download from companies, experts, and individuals. For example, *Nuclear* is a 3D serious game that dynamically models an interactive atom and teaches the periodic table, *Atoms* – educational logic quiz. *Nuclear inc 2* (nuclear power plant simulator) is a serious game that not only teaches how the nuclear reaction works and how the energy of nuclear fuel is converted into electricity, but also educates how to protect yourself and your family against radiation, and explains the causes of nuclear accidents, such as Chernobyl or Fukushima. This app is available in four different languages, has a storyline, and different levels of game difficulty. Another type of application, for example, *Augmented nuclear plants*, contains educational materials in the form of text, pictures, and augmented reality models, which can be used not only informally, but also in formal education classes (Tab. 3).

The use of simulations and serious games in learning is growing. While the theoretical benefits of digital games for formal and informal teaching and learning are constantly being studied, there is still not a big choice of mobile apps that inform and develop atom literacy.

**Tab. 3:** The list of freely available nuclear educational apps and games

| No. | Name | Target learners | Description (purpose) | Creator | Platform |
|---|---|---|---|---|---|
| Tests & quizzes | | | | | |
| 1 | How radioactive are you? | Children | Online self-evaluation test | ANSTO | Online at http://howradioactiveami.com/ |
| 2 | The Brain Challenge Quiz | Children | Online quiz. Could be combined with online *Nuclear Reactor Simulator* | Dalton Nuclear Institute | Online at http://www.dalton.manchester.ac.uk/connect/learn/brain-challenge/ |
| 3 | Atoms | Family | 2D puzzle | Elvista Media Solutions Corp. | Android |
| 4 | Augmented nuclear plants | Formal and informal learners | An introduction to nuclear reaction, fission and fusion lesson, and assignments to students | M. Chardine | Android |
| Serious games | | | | | |
| 1 | Half-life hero | Children | Teaching about nuclear medicine and industrial isotopes, and their benefits to society | ANSTO | Online at https://archive.ansto.gov.au/static/halflifehero/ iOS |
| 2 | Elementals | Children, teachers | Learning the Periodic Table, supporting science education in the classroom and practicing on the go. | ANSTO | Online at https://archive.ansto.gov.au/elementals/ Android, iOS |
| 3 | Nuclear | Family | Learning about each of the elements of the periodic table by constructing a stable version of that element. | Escapist Games | iOS |
| 4 | Atom Builder | Children, teachers | Discovering the uses and properties of common isotopes, locating elements in the periodic table. | ANSTO | Online at https://archive.ansto.gov.au/static/atombuilder/ |

**Tab. 3:** Continued

| No. | Name | Target learners | Description (purpose) | Creator | Platform |
|---|---|---|---|---|---|
| 5 | Nuclear Inc 2 | Family | Serious game, teaching and training the basics of managing a nuclear reactor and a nuclear power plant in general. | Lomakin Dmitrij (ru. Ломакин Дмитрий) | Android |

## Virtually Enhanced Touring to Engage and Interact with New Knowledge

As stated in Yung & Khoo-Lattimore (2019), Oculus (https://www.oculus.com/), Sony (https://www.playstation.com/en-gb/explore/playstation-vr/), Samsung (http://www.samsung.com/global/galaxy/gear-vr/), Google (https://vr.google.com/), HTC (https://www.vive.com), and Microsoft (https://www.microsoft.com/en-cy/hololens) have unveiled virtual and augmented reality products to the mass market. The virtual reality tour to ANSTO's OPAL multipurpose reactor helps to discover how things happen on the atomic scale. Although virtual reality becomes more and more popular, it requires special VR helmets, glasses, and other devices. Because of that, 2D and 3D virtual tours remain popular. For example, *Nuclear Reactor Simulator* or *Nuclear Power Plant Simulator* is an "old fashioned" 2D simulator, developing nuclear literacy among various age audiences (Tab. 4).

The virtually enhanced tourism is becoming very popular, but our research has shown that there are only a few freely accessible technology-enhanced atom tourism routes. To stimulate learning, these routes not only need to have elements of experiences, but also be co-created together with teachers, instructors, and other learners. The researched concepts and technological solutions are presented in Tab. 5.

While playing serious games and traveling virtual journeys, formal and non-formal learners can enhance their nuclear education. They can learn from digital books and educational apps and self-virtually evaluate their advancement with tests, quizzes, puzzles, and similar techniques. Virtual and augmented reality tours, and online and mobile games are gaining popularity. Digital text and voice guiding help players to navigate virtual routes. Through these technological solutions, online tours and mobile apps are developed. In passive instruction-based learning (Anderson, 2008), the learner acts only as

**Tab. 4:** The list of popular freely available nuclear education tours and simulators

| No. | Name | Target learners | Description | Creator | Platform | Online guiding | Touristic route |
|---|---|---|---|---|---|---|---|
| 1 | ANSTO VR | Family | VR tour inside Australia's OPAL multi-purpose reactor | ANSTO | Android, iOS | Voice, text | yes |
| 2 | Nuclear Reactor Simulator | Learners, teachers | 2D nuclear reactor simulator | Dalton Nuclear Institute | Online at http://www.dalton.manchester.ac.uk/connect/learn/nrs/ | Voice | no |
| 3 | Power Plant Engineering | Formal and informal classes and individual learners | Handbook of Power Plant Engineering, covering reference materials and digital book | Softonic | Android | text | no |
| 4 | Nuclear Power Plant Simulator | Family | The goal is to produce enough electricity to light up the entire city without causing a dreaded nuclear power plant meltdown. | Majik Mike Simulators | Online at http://www.nuclearpowersimulator.com/ | text | no |
| 5 | Nuclear Power Plants | Family | The description of nuclear power plants from all around the world | Kirill Sidorov | Android | text | no |

**Tab. 5:** Concepts and most popular technological solutions for virtual nuclear education

| Concepts | Technological solutions | Challenges |
|---|---|---|
| Virtual reality solutions | Online games, game apps | It is difficult for the user to accept immersive experiences and feeling of presence; a new level of interaction achieved through all human senses |
| Virtual tour technologies | VR/AR tours, simulators, navigation using text, voice, maps, and GPS data | Challenges with virtual reality hardware – mobility, freedom of movement, speedy internet, data security |
| Nuclear education | Educational apps, online tests, online quizzes, online puzzles, digital books, online games, game apps, VR/AR tours, and simulators | Challenges with high-quality educational apps - expensive to build, quality graphics, much advertising in free apps, convincing teachers to use informal education classes, assessment, and evaluation of learning results and achievements |
| Nuclear information | Online tours, mobile apps, 360 and panorama videos | Some learners find it difficult to immerse into virtual activities, they experience a disconnection between online presence and live behavior |
| Nuclear technologies | Complex calculations, modeling, VR/AR tours | Lack of nuclear staffing able to produce virtual materials for specialists, not all scientific material is freely available on the internet |

an absorber of information materials, and the teacher provides the knowledge reflected only in digital books and digital guiding using online text solutions. In our research, we concentrate on learning which takes a more active form of acquiring and accumulating knowledge. The learner himself or herself decides what information he or she needs, chooses to learn formally or informally, collects online information, constructs knowledge, and formulates the meaning of the given material. Internet and smart technologies enhance the learning experience. For example, an online self-evaluation test "How radioactive you are?" explains natural radiation (using text, images), shows practical examples (with photos, images, videos), and allows the learner to self-evaluate (using an interactive test). In this example, all the phases of Kolb's experiential learning theory (e.g. Kolb, 1984; Kolb, Boyatzis & Mainemelis, 2001) are supported. Interactivity is created by providing a variety of teaching and learning contents and enabling the learner to decide what content to choose or which path to follow. For instance, when examining augmented nuclear plants, the learner observes online materials, conceptualizes and plans the

new virtual experiments, practices and self-evaluates on the net, and can make new observations. A similar search of experience was observed in technology-enhanced tourism (Neuhofer, Buhalis & Ladkin, 2014). In their analysis of technology as an enhancer of experience, these authors described two competing experiential learning scenarios. In the first scenario, technology was an integral part of the co-construction of the tourism experience. In the second scenario, technology played a complementary role in acquiring a tourist experience (ibid.). Our framework falls into the first scenario, manifesting contemporary technology as an active co-creator of nuclear education virtual experiences.

One of the biggest challenges to encourage learners to actively co-create knowledge is that of engaging students. Serious games can provide such motivating and engaging learning experiences (Kiili, 2005). In serious games, learning is explained as a cyclic process through direct immersive experience and problem-solving in the game world: permanent action and continuous practices (ibid.). For example, in ANSTO serious games *Half-life hero*, the player is a scientist who must solve real-life problems, manage the nuclear reactor, and save his country from a catastrophe. For this, a quick reaction to decision-making is necessary. The time-based element of gameplay provides a challenging, yet rewarding mechanism for players of all skill levels, while the game's quirky design appeals to kids and adults alike. In this serious game, real-life problems are presented in a fun and attractive way, which creates an immersive experience. For Kiili (2005), an experiential gaming model is based on three theories: experiential learning theory (Moon, 2013), flow theory (Nakamura & Csikszentmihalyi, 2009), and game design. In our study, the serious games part is a siding of nuclear education that is explained from experiential learning lenses (as in Kiili's), adding immersion and problem-solving.

## Geolocation Technologies of Virtual Tours Development

Geolocation is a technology that uses data acquired from an individual's computer or mobile device to identify or describe the user's actual physical location (Kapoun, 2016). Geolocation technology collects two types of data. It is important to gather information about the learner or their device and the data server. Data correlation and cross-references are then performed to produce the most accurate result. (Estes, 2016). In virtual nuclear education, it is very important to explain not only the physics or benefits of the atom to man and nature but also to visually show the specific locations associated with the atom (uranium ore mines, nuclear power plant construction sites, other specific locations). Exploration of the modern nuclear world and the history of an atom can be

done in two ways. Firstly, it is possible to travel and participate in a guided tour or visit science and technology museum exhibitions. When learning about an atom, this method is not always appropriate. Even dormant uranium ore mines or nuclear power plants do not usually allow visitors to come because of special security reasons. Secondly, an individual learner could virtually reach the desired place of the world, while sitting at home or school in front of a computer or smart device and exploring nuclear history, culture, peculiarities of hard-to-reach countries, places, and spaces. This method is especially useful when visiting sensitive areas or remote objects. Widespread *Google* tools, free online services, and products allow teachers and their students not only to reach atom-related sites but to create their personal virtual tours and itineraries without special programming skills. Examples of such tools are *Google Maps* (*google.com/maps*), *Earth* (*google.com/earth*), *Tour Builder* (*tourbuilder.withgoogle.com*), *Tour Creator* (*arvr.google.com/tourcreator*), and others. Teachers can use these tools in their lessons of geography, physics or history, designing teaching materials, and presenting active tasks to learners. These tools help develop not only learner's nuclear literacy, but general abilities, such as learning to learn, creativity, or communication.

Gorelick et al. (2017) studied *Google Earth* Engine "as a cloud-based platform for planetary-scale geospatial analysis that brings Google's massive computational capabilities to bear on a variety of high-impact societal issues including deforestation, drought, disaster, disease, food security, water management, climate monitoring and environmental protection" (p. 18). With *Google Earth* or *Google Maps* tools, learners can explore any place on the world map. *Earth Studio* (*google.com/earth/studio*) is an animation tool for Google Earth's satellite and 3D imagery. This tool help educators to record and explain lessons with animated videos and 3D pictures. Audiovisual materials could be linked to a specific location or place in the world. When developing interactive online assignments with these tools, educators can apply integrated materials to nature, humanities, or STEM lessons. Investigating how children accomplish place in everyday lives, Danby et al. (2016) showed examples how to teach preschool children geography and social interaction with *Google Earth* tool. This tool helped researchers recognizing children's competence to manipulate their social and digital worlds. Investigating to what extent the implementation of a *Google Earth*-based science curriculum increased students' understanding of nature structures, developing scientific reasoning abilities, and constructing science identity, Blank et al. (2016) discussed that students, who applied geospatial technologies in their learning, developed not only specific knowledge of earth understanding, but their science identity, and science reasoning.

Geolocation storytelling creates an interactive, and emotional, connection to learning, engaging such skills as curiosity, critical thinking, empathy, and in some instances, a call to action. In order to make educational stories easier to understand for learners of all ages, researchers recommend that it be presented in the form of static and dynamic images, not just text. Currently, the most popular forms of presenting this type of material are images, videos, infographics, and charts. By creating a variety of video materials, educators expect learners' engagement and motivation to increase. One of the tools for creating inclusive nuclear teaching materials and geolocation stories is *Tour Builder*. The *Tour Builder* was developed for informal sharing and peer-learning of adults and military veterans. Now, this tool is more widely used in formal education and informal classes. *Tour Builder* could serve as an interactive storytelling tool that connects learners to places using *Google Maps* and multimedia content. When creating an integrated educational material with *Tour Builder*, the teacher could explain the history of a specific place or power plant, tell nuclear stories with text, photos, pictures, and video materials. *Tour Builder* could be used to research the locations of famous scientific discoveries, create a tour of unusual geological features, explain how to spend summer vacation, explore the famous science and technology museums around the country, and virtually participate in physical and chemical reactions or manage nuclear processes. Teachers, sharing their ideas how to creatively use this tool, talk about using *Tour Builder* for their animal habitats and zoology classes, geographic biomes, explanation of weather and climate, social science lectures of indigenous people, and language studies. The possibilities of *Tour Builder* application are limited only by educator's imagination. Learners could use the tool to tell and share nuclear stories and personal experiences. They could link telling with a specific location on the map (Fig. 8).

*Tour Creator* allows educators to create 360-degree virtual tours and gamified scenes. To enhance their tours, educators could add audio recordings to scenes and link them with the specific place on Google map. The educational material created by this tool can be linked to virtual tours or exhibitions inside and outside museums and science and technology centers. Virtual educational tours could be embedded on educational website, virtual learning environment, blog, or social network. *Tour Creator* can be used creatively for analyzing any educational material and developing active tasks and assignments. For example, in a nuclear biology lesson, it is possible to create a virtual tour of the human eye – to observe the physiological and medical structure of the eye, the essential biological functions, and other topics (Fig. 9).

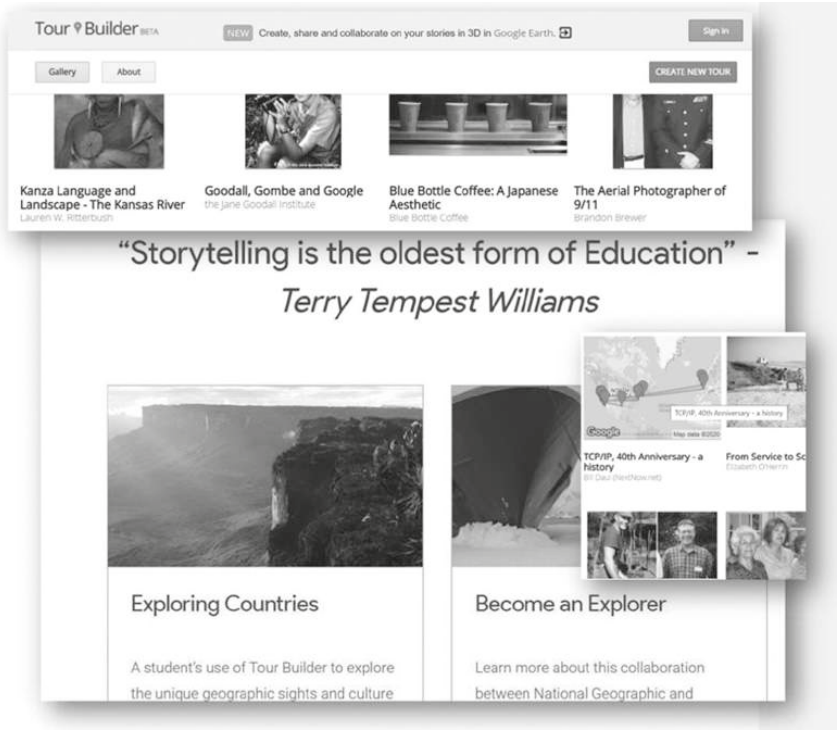


**Fig. 8:** *TourBuilder* story gallery

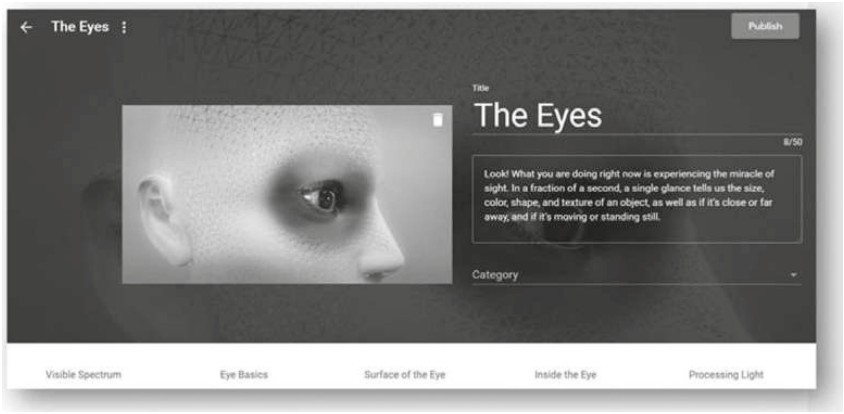


**Fig. 9:** Teaching and learning materials for nuclear biology classes created with the *Tour Creator*

The *Google Expeditions* (*edu.google.com/products/vr-ar/expeditions*) tool lets teachers combine virtual reality content and supporting learning material into one collection. Such an expedition or virtual tour can be installed not only on a computer but also on any smart device of a teacher or student. The tool allows teachers, along with their students, to visit virtually anywhere in the world: visit the most famous science and technology museums, observe complex or dangerous technical processes and reactions, earth and space, mountains and the ocean, and more. Teachers, who are experts in using *Tour Creation* technology say that the *Google Expeditions* app for mobile allows educators to guide tours with students following along. This application permits the teacher to keep students at the same pace while they discuss different scenes as a class. With the *Expeditions* app, classrooms have no boundaries. Davis and Schmutz (2019) presented an example, how *Google Expeditions* could be used to engage school children in the learning process. They provided examples from history, biology, anatomy, and other classes and guided teachers to use virtual reality applications in formal school settings. By presenting practical examples, Davis and Schmutz (2019) motivate educators not only to use pre-made entries in the *Google Expeditions* program, but also to create their virtual educational tours, and to make their virtual reality tours with a 360° camera.

*GeoGuessr* tool (*geoguessr.com*) lets individuals to create maps of places they visited and link these places to *Google Maps*. Learners could explore the places, play educational geolocation games, and perform teacher-created assignments (Fig. 10).

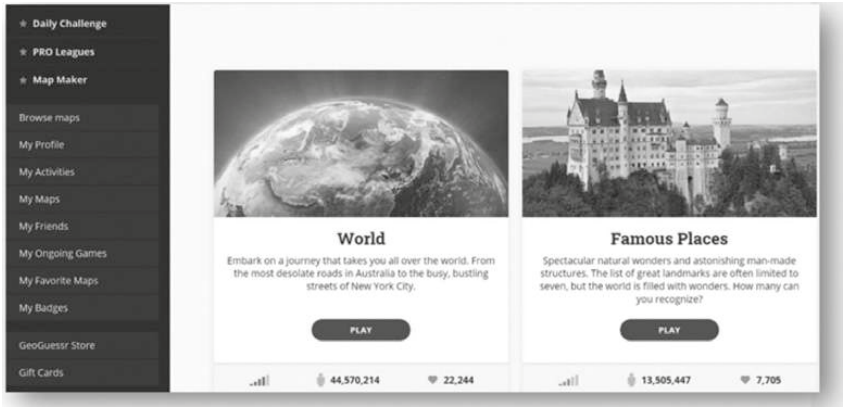


**Fig. 10:** *A snippet of the GeoGuessr Tool web site*

In *GeoGuessr*, learners could browse and create maps, guess the geographic coordinates of specific places, and play geolocation games. The tool can be used in history, literature, or integrated lessons. Also, the tool can be used for individual or group educational activities. Girgin (2017) presented an example of *GeoGuessr* use in geography classes. These researchers found that all learners who participated in *GeoGuessr* activities during geography lessons enjoyed game-based learning. A lot of them gave positive impressions about the game. While playing, they gained map reading skills, learned geography-related content and grew to solve problems by reasoning competence. Scholars argued that *GeoGuessr* learners reach to information and were motivated to study by themselves.

*TheTrueSize* (*thetruesize.com*), *Landlines* (*lines.chromeexperiments.com*) and *Time-lapse* (*earthengine.google.com/timelapse*) tools help you understand history, imagine the size of learner country, teach geography, national peculiarities of the country or region, and help learners to conduct geo-experiments on the area or place. The *GeoGreeting* tool (geogreeting.com) can be used for integrated language learning. With this tool, learners can send aerial imagery messages from *Google Earth* and associate foreign language learning with the history and geography of a particular country. The tool allows a learner to enter a message of up to 40 characters and email or share a link. When a learner receives such a message, he or she is associated with a particular place in the world.

Teachers can use *Space* (*google.com/maps/space*) or *AccessMars* (*accessmars.withgoogle.com*) tools to illustrate the physical and geographical structure and location of our planet in the Solar system. These tools use the latest NASA data, maps, and images, 360 videos and audio materials. In this way, students are introduced to the latest scientific achievements. Learning with tools motivate them to explore the world (Fig. 11).

These tools can be used for project-based learning. The creative use of tools in formal and informal settings stimulates students' curiosity and encourages exploration.

In this section, we have reviewed only some of the educational tools that can be used for virtual nuclear tour development. The attractiveness of tools is enhanced by the fact that they are freely accessible to all, can be used in formal and non-formal learning, and teaching with these tools requires only basic skills of internet or smart device usage. All these tools can be easily applied in virtual nuclear education.


**Fig. 11:** *A snippet of Space and AccessMars tools*

## Discussion and Conclusions

This mapping review illustrates the complex nature of virtual reality solutions and virtual tour technologies applicable to online nuclear education, nuclear information, and nuclear technology studies covering topics of empirical scientific research, online, and smart solutions. Experiential learning tools, such as serious games and virtual tours, contribute to teaching while playing. Virtual and augmented reality gaming, going beyond the edges of the real world, occupy different areas, including education. It provides immersive experiences, an advanced level of interaction and augmented serious content. Five main senses, such as sight (visual), sound, touch (tactile feedback), smell, and taste, are activated during VR activities. The technology acceptance model and the plethora of its modifications (e.g. Lee & Lehto, 2013; Marangunić & Granic, 2015) look for an answer to the question – what causes people to accept or reject information technology? (Davis, 1989, p. 320). In our research, we join this discussion (see "accepting technologies" part in Fig. 1). The answers may

be the perceived ease of use, the permanent availability, the perceived usefulness, the task-technology fit, content richness, vividness, and other dimensions. Ibrahim, Khalil, and Jaafar (2011) added to this: enjoyment, performance anticipation, and effort expectancy and gaming experience. Nuclear education tours and simulators, for example, ANSTO's VR tour inside Australia's OPAL multipurpose reactor, are an unforgettable virtual or augmented journey that allows us to explore science and make personal discoveries. The key determinants in such tours are ease of use, permanent virtual availability, immersion, fun, guiding, challenging, and raising curiosity (see Fig. 2).

The digital guides help to create virtual educational experiences by interpreting events, organizing activities, explaining places, accommodating spaces, managing time, telling stories, and co-constructing knowledge. According to Bohlin and Brandt (2014), digital guides rest on two pillars. These pillars are technology (hardware and software) and narrative (the story and the way it is composed and delivered to the learner). The first pillar – digital guiding – was significant for the virtual tours and serious games to instruct the learning process, to tell the story, navigate, explain, motivate, and encourage (Battad & Si, 2016). In the virtual tours, directions, roads, do's and don'ts, rules, instructions, helps, additional text, and audio information can be provided. In serious games and virtual tours, virtual guiding informs, helps to experiment, observes, gains knowledge and develops skills, solves educational tasks, challenges, and conceptualize (see Fig. 2). For the virtual guiding, one technical aspect that is not widely discussed in the literature is GPS functionality. In the investigated nuclear touring examples, this was not implemented, although it is becoming popular in modern tours. The second main pillar described in Bohlin and Brandt (2014) – the virtual narrative construction to inform and educate – has been minimally explored in empirical scientific articles. Although in online materials such information was not provided, either, in this case, the contacts of experts who can give more information to the teachers were identified.

Using the tools described in this section, students acquire and develop these competences: critically read, interpret cartographic and other visualizations in different media (interpretation); be aware of geographic information and its representation through GI and GIS (learning about); visually communicate geographic information (produce); describe and use examples of GI applications in daily life and in society (applying); use (freely available) GI interfaces (use); carry out own (primary) data capture (produce or gathering); be able to identify and evaluate (secondary) data (use or evaluate); examine interrelationships (analyze); extract new insight from analysis (produce); and reflect and act with knowledge (action: decision making and applying in real world) (Zwartjes & Torres, 2019).

## Limitations

Since virtual and augmented reality technologies are becoming more and more popular, it is important to note that today's virtual and augmented reality solutions are still limited. Newer applications transform virtual and augmented reality into content for the virtual spaces, simulations, and 360 videos. Although technological solutions are getting more accessible to the average consumer, special glasses, hand-mounted displays, sensors, or cameras are still needed for fully immersive experiences. Virtual and augmented reality is motivating, and most of the young generation of learners have a positive attitude towards modern technologies, which are exciting, challenging, and allow to interact, create, and manipulate in virtual environments (Domingo & Bradley, 2018). However, some studies of adult learners reported the lack of AR/VR awareness because of unwillingness to accept virtual substitutes (see *Challenges* part in Tab. 1 and Tab. 4).

While proposing serious games and tours for virtual nuclear education, we can observe certain limitations. In nuclear education settings (formal and informal), these technologies are mainly adapted to the young generation of learners, having positive attitudes to educational technology – to the learners who accept technology. Research shows that not all the students, called digital natives, are competent in using technologies in educational environments. In addition, it is crucial to present the teaching material in a clear, understandable, and attractive way, considering the age and initial preparation of the learner. The biggest challenge is not only to create virtual materials on nuclear education in the text format, but also, together with computer scientists and engineers, to develop virtual narrative, immersive games, simulation apps, and other types of virtual reality solutions. The challenge for nuclear technology researchers remains the communication of scientific information in a learner-friendly format. Having this in mind, the joint forces of academic staff and technology professionals – actively involved in creating virtual learning scenarios, nuclear education, and information materials – are needed to maximize learning benefits.

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# 2

Ineta Dabašinskienė

# Place and Language Transformations in a Post-Soviet Landscape: A Case Study of the Atomic City Visaginas

**Abstract:** The chapter analyzes the case of a post-Soviet city Visaginas (Lithuania) due to its socialist and mono-industrial heritage at present experiencing an extremely complicated transition period. Today Visaginas provides a very special example of Lithuanian ethnic landscape and represents a geographically, culturally and ideologically isolated place. Its ethnic composition is very diverse, but mainly consists of Soviet-period immigrants with a strong pro-Soviet identity who arrived in the 1970s. The collapse of the regime and the local economy have brought anxiety, uncertainty and fear not only to the inhabitants, but also to the city itself, to its identity and its future. This study focuses on the multiple issues, relying on the concepts of place identity, language ideologies, policies and practices in the framework of the global new economy and commodification. The linguistic landscape and soundscape of Visaginas demonstrated varied linguistic resources of the city: from the dominance of Russian, efforts to use Lithuanian, and English in written signs. The attempts to manifest linguistic diversity as a social capital of the city are obvious and have good potential. Whatever changes in individual repertoires and group preferences will take place in the future, bilingualism at the level of society seems to be the most desirable outcome.

**Keywords:** linguistic landscape, multilingualism, Russian-speakers, language commodification, language attitudes, atomic city, Visaginas

## Introduction

Mobility is a reality of human life. People have always moved around and changed places for different reasons – political, economic, social and cultural. Wars, changes of regimes, conflicts, lack of resources, climate disasters or just a desire for adventures have forced humans to dislocate. In the age of globalization and high technologies, mobility has become a typical feature of modern societies. Diverse forms of mobility bring about changes in neighborhoods and communities, making them more hybrid as different languages and cultures blend. This is a fact. However, the imminent question is always the same: do we consider this diversity as a strength of social and economic well-being of the society in question? Or do we fear that multiculturalism and multilingualism

will bring instability to the homogeneity of the society and weaken its traditional values? It is obvious that multilingual and multicultural groups are more complex than "pure" and homogeneous societies. The complex issues of diversity and integration are closely tied with the manifestation of power – social, political, economic, and linguistic, which fosters opposition and possible conflicts between the groups of "we, ours" and "they, theirs" (Schieffelin, Woolard, and Kroskrity, 1998 ). Tensions between the majority of population and minorities, mostly immigrants, have become evident in many European countries where cultural and linguistic diversity has been promoted and served to advocate tolerance and openness. However, other cultures and ethnicities are greatly welcomed mainly in "authentic" domains, such as folklore, crafts, music and, especially, cuisine and are tolerated under one condition – they have to be well "integrated", which most often means "assimilated" (Bloomaert and Verschueren, 1998). Moreover, linguistic integration is considered a must to become a true member of the society.

Thirty years ago, linguistic integration of Russian speakers was (and still is) at the center of the integration policy in the Baltic States because of the Soviet regime, which was marked by the supremacy of the Russian language and asymmetrical bilingualism, with Russian dominating in high-level spheres and Russian-speaking minority groups (Marten, Lazdiņa, Pošeiko and Murinska, 2012, p. 290). The Baltic States had to take necessary steps to re-introduce all functions of national languages after many years of Russification policy, therefore they had implemented "thick", "control-oriented" policies (Spolsky, 2004 ; Siiner, 2006). All three countries (Estonia, Latvia and Lithuania) have introduced national language laws, supplemented by a number of amendments and normative acts that define the status, teaching and use of languages in the state. Language policies guarantee that the state language is used and promoted, and that the relevant institutions work properly to maintain and develop the standard language. On this view, bilingual practices, code switching and borrowing become a problem (Vihalemm and Siiner, 2011).

The Russian-speaking population in the Baltic countries has lost its "guaranteed" position; as a result, the three states have been faced with the challenges of adopting new language planning and integration policies regarding Russian nationals (Vihalemm, Siiner and Masso, 2011, p. 116). Today, national languages are dominant, but Russian keeps a strong position in many domains despite the fact that language acquisition policies for the Russian-speaking population

have aimed at developing their competence in the state languages[1]. Lithuania due to certain historical and political circumstances had a "better" situation than other Baltic States regarding its ethnic composition, as ethnic minorities, including Russian speakers, compose less than 20 per cent of the population. In Lithuanian cities the monolingualism of the dominant language (an official state language) is a result of the national language law requirement. However, local practices show the use of minority languages as well as an increasing visibility and use of global English. The English language is now the first foreign language taught at schools and is used as the main lingua franca in international communication. Moreover, not only does it appear in public signage for symbolic effects, but is also used in many activities (professional, leisure), especially by young people.

As is known, the build-up of specific contexts and unique arrangements of demographic, social, political and attitudinal factors in different localities may play an important role. The aim of this study[2] is to analyze the case of a post-Soviet city with special focus on its community, to reflect on the socialist past, to discuss the complicated present, and to envisage perspectives for the future. The town of Visaginas, a "migrant island" (Baločkaitė, 2010) in Lithuania, due to its socialist and mono-industrial heritage at present experiences an extremely complicated transition period. In what follows, the multiple issues of Visaginas will be disputed relying on the concepts of place identity, language ideologies, policies and practices.

1 The linguistic policies of the Baltic countries and the integration issues of the Russian-speaking population have been reported and discussed in many publications (Hogan-Brun, Ozolins, Ramonienė and Rannut, 2009; Rannut, 2008; Hogan-Brun and Ramonienė, 2005; Muiznieks, 2010; Kasatkina, 2007; Potashenko, 2010, etc.). For the new directions and discussions on languages in the Baltic States see Lazdiņa and Martnen (2019).

2 This study is a part of the EDUATOM (The Didactical Technology for the Development of Nuclear Educational Tourism in the Ignalina Nuclear Power Plant (INPP) Region; No. 01.2.2-LMT-K-718-01-0084/232) project, which aims to develop an educational nuclear tourism route in the INPP region in Lithuania. It is funded by the European Regional Development Fund according to the supported activity "Research Projects Implemented by World-class Researcher Groups" under Measure No. 01.2.2-LMT-K-718.

## Visaginas: From the Planned Soviet Past to the No-Where Future?

The integration of the soviet republics, including the Baltic states, via industrial projects was very important for the Soviet Union to establish and maintain fixed economic structures: "(. . .) construction of large-scale industrial structures and special industrial towns served as an important tool for integrating the Baltic States into the united network of Soviet space" (Cinis, Drėmaitė and Kalm, 2008, p. 227).

Visaginas presents the case of "the planned socialist towns". As argued by Baločkaitė, "the planned socialist towns emerged first as the workers' settlements for socialist industrial enterprises. They, alongside their industrial enterprises, served not only economic aims, but also ideological ones" (2012, p. 45–46). These planned towns were mostly mono-industrial, with specific industries, such as nuclear energy in Visaginas, or uranium production activities at the plant in Sillamäe, Estonia and the hydroelectric power plant in Aizkraukle (former Stučka) in Latvia.

These towns were constructed as exclusive sites of socialism where city infrastructures were planned by leading architects, the living standards were above the average of the country (Cinis et al., 2008), and "the socialist culture and way of life were openly celebrated" (Baločkaitė, 2012, p. 46). These towns, according to Baločkaitė, "were projects of social engineering designed to develop a new type of community and personality. As model communities for socialism, they were meant to legitimize their socialist regimes, draw a line with the past, and signify the beginnings of a new socialist era" (2012, p. 46). A very specific feature of these towns was the absence of history, as they were built as a new enterprise in scantily populated regions. The first inhabitants usually were migrant workers without a common past, only sharing a socialist present.

Visaginas (former Sniečkus), as a planned soviet town, has become a symbol of economic and industrial progress of the USSR. It was built in 1973 as a satellite settlement to the Ignalina Nuclear Power Plant (INPP), the most progressive nuclear power plant at that time. In 1975, the symbolic cornerstone of the town was laid (see Fig. 1), and workers from different areas of the Soviet Union came to build the atomic town. The town was named after the first secretary of the Central Committee of the Lithuanian communist party, Antanas Sniečkus (in 1992, Sniečkus was renamed Visaginas). In 1983, the nuclear power plant was launched. Visaginas was supposed to become "the town of nuclear energy". The main employee was the Nuclear Power Plant, which played a vital role in


**Fig. 1:** The bilingual sign (Lithuanian-Russian) on a stone marking the establishment of the town in 1975 (The town for people of a nuclear power plant will be built here, August, 1975).

establishing the town's identity. In 1999, there were 5108 jobs at INPP, making up 38 per cent of the town's employment (Kavaliauskas, 1999, p. 248).

However, in 1986 the tragic catastrophe in Chernobyl temporarily stopped construction works. After the re-establishment of Lithuanian independence, emergence of the Green movement and other protests, the construction of the third reactor was suspended and its demolition began in 1989 (Baločkaitė, 2010; Kavaliauskas, 1999). In negotiations with the EU, Lithuania had to fulfill the requirement to gradually close the atomic plant. Therefore, the first reactor was stopped in 2004, the second in 2009. The two reactors are currently undergoing a decommissioning process. By 2030, the site of the two reactors should be ready for reuse.

During the first two decades of a new city's life, Visaginas was the most rapidly growing city in Soviet Lithuania due to immigration and a high birth rate; more than 25,000 immigrants arrived (Kavaliauskas, 1999, p. 30). However, the number of Lithuanians grew slowly from 5.8 per cent in 1979 to 14.96 per cent in 2001 (Kavaliauskas, 1999, p. 59). At the power plant, the percentage of Lithuanian workers was also quite low. After 1990, with uncertainties about the future of the nuclear power plant and employment looming, the number of inhabitants stabilized at around 30,000.

Today Visaginas provides a very special case of Lithuanian ethnic landscape and represents a geographically, culturally and ideologically isolated place. Its ethnic composition is very diverse, but mainly consists of Soviet-period immigrants with a strong pro-Soviet identity who arrived in the 1970s. After the declaration of Lithuanian Independence, Visaginas went through different stages of difficult developments, tensions and uncertainties in a search of its new identity and forms of co-existence with the rest of Lithuania. Today, the ethnic composition of the town still reminds the former Soviet Union with 52 per cent of the population being ethnic Russians, Belarusians (9.89 per cent), Poles (9.32 per cent) and Ukrainians (5.16 per cent), the rest belong to almost 40 different nationalities that mainly speak Russian. Lithuanians are a minority group with only about 15 per cent. Due to emigration in 2001–2011, the number of inhabitants in Visaginas decreased by 25 per cent; today there are only 19,000 inhabitants, of which almost 80 per cent are Russian speakers.

The number of Russian-medium secondary schools and pupils attending them is decreasing, with some Russian-speaking families sending their children to Lithuanian primary schools and Lithuanian kindergartens. Therefore, the number of schoolchildren is also decreasing, and in general, quite a number of young people consider emigration as their future choice. Almost 60 per cent of school graduates choose to seek higher education; however, half of them study not in Lithuania, but in the UK, Finland, Latvia, Russia, Belarus or Ukraine. Research shows that mainly in mixed families, if one family member is Lithuanian, children continue their education in Lithuania (Šliavaitė, 2012).

Many inhabitants of Visaginas were first-generation immigrants, with their relatives and professional ties in the Soviet Union; they still maintain strong diasporic connections with Russia and other former Soviet republics. However, thirty years of living in a new reality force Visaginas community to develop its relations with Lithuania and Lithuanians and call them to balance their loyalties between the two states (Baločkaitė, 2012). In order to understand this locality better, we must keep in mind that Visaginas has experienced a two-fold "tragedy": the collapse of the Soviet Union and declaration of Lithuanian independence along the decommissioning of the INPP. These realities have brought anxiety, uncertainty and fear not only to the inhabitants, but also to the city itself, to its identity and its future. As it looks now, the search of a new identity, including opportunities for the economic development, does not provide any sound solution for the city. It is important to note that the population of Visaginas was and still is (to a certain extent) highly educated and qualified, as the power plant needed experts for the complicated jobs. Therefore, small businesses or local industrial projects are not considered an attractive

alternative for the city's future. Today, due to a long stagnation period, emigration and slow infrastructural developments, the city lost its economic and social status, prestige and became *"the dying city", "the Soviet city",* and *"the ghost town".*

## Theoretical Approach and Methodological Remarks

Social scholarship features intensive debates on place and identity; *sociolinguistics of place, belonging and mobility*, on the other hand, are rather new concepts providing valuable knowledge on language and place relationship (Auer, 2013; Blommaert, 2010; Cornips and de Rooij, 2018; Pennycook, 2010). Usually these concepts include discussing actual resources of languages deployed in real sociocultural, historical and political contexts, which, according to Blommaert, focus "not on language-in-places but on language-in-motion, with various spatiotemporal frames interacting with one another" (2010, p. 5). We also see that "territorialized" patterns of language use are complemented by "translocal" or "deterritorialized" form of language use, and that the combination of both often accounts for unexpected sociolinguistic effects (2010, p. 4–5).

These approaches invite to rethink the locality from the perspective of authenticity and tradition co-existing with various forms of local and global realities: urbanization, the new economy, multilingualism, hybrid communications and new types of identities. This study intends to contribute to the scholarship of place identity related to the soviet and mono-industrial heritage as well as the Russian-speaking community and its future perspectives based on a qualitative form of analysis. The aim of this paper is multifold: to provide not only a sketch of historical development of the town, which is essential in order to understand the complexity of the place, but also to discuss and analyze the concepts of place, language and identity in the framework of the global new economy and commodification. The main approach of the study is a qualitative one. The Linguistic Landscape (LL) methodology was used for initial screening of Visaginas public and private written signage in order to recognize the patterns of language policies, status and use. The main task was to take photos of private and public signs where at least two languages were present. Up to forty photos were collected in different areas of Visaginas. The objects included private (companies, shops, services, hotels) and public (cultural center, municipality, school, etc.) institutions. However, it should be noted that in general not many signs were found compared to other Lithuanian cities (Muth, 2012; Ruzaitė, 2017). Our intention was not collecting as many pictures of a location as possible as usually is the case of the LL method, which often relies on a

quantitative aspect. For this study, simple quantitative data are unlikely to help explain complex societal issues. We assume that the detailed explanation of facts by reflecting on the political, social or psychological context might provide a better understanding of the people, locality and its linguistic dynamics.

Additionally, interviews with local representatives of the most prevalent ethnic groups (Russians, Belarusians, Ukrainians, Kazakhs and Uzbeks) were conducted to critically reflect on their linguistic practices and attitudes. In total, nine representatives were recorded: 2 Kazakhs, 2 Russians, 2 Ukrainians, 1 Lithuanian, 1 Belarusian and 1 Uzbek. There were seven females and two males participating in this study, all of them were of senior age (half of them retired). The duration of interviews varied greatly, from two hours to half an hour. The data were gathered during several sessions at different times (in 2018 and 2019) and amount to eleven hours of recordings. We suppose that both public arena (signs) and the informants' personal reflections will provide a possibility to understand how the local community marks its identity and demonstrates linguistic practices.

Let us introduce the Linguistic Landscape approach as for the potential reader of this volume this sociolinguistic methodology might be unfamiliar. LL is a relatively new field of study that encompasses diverse approaches to sociolinguistics, language policy, semiotics, etc. (Backhaus, 2009; Cenoz and Gorter, 2006; Landry and Bourhis, 1997; R. Scollon and S. W. Scollon, 2003; Spolsky, 2004). LL usually performs two main functions: the first is to inform about the diversity of languages present on signs and to provide information about the sociolinguistic composition of an area; the second is a symbolic function, as the presence of one's own language on signs can be interpreted as the fact that this language has a special value and status in a certain sociolinguistic context (Ruzaitė, 2017).

Globalization and mobility have different impacts on cultural, social and political life of many places. The city of today reflects dynamic linguistic landscapes and mainly exhibits signs of multilingualism. Linguistic landscapes, according to Landry and Bourhis, usually refer to "the language of road signs, advertising billboards, street names, commercial shop signs, and public signs on government buildings that combines to form the linguistic landscape of a given territory, region, or urban agglomeration" (1997, p. 25). Moreover, linguistic landscape includes "any sign or announcement located outside or inside a public institution or a private business in a given geographical location" (Ben-Rafael, Shohamy, Hasan Amara and Trumper-Hecht, 2006, p. 14). Urban spaces with various written signs refer to different modes of linguistic diversity; help to discover attitudes and beliefs, ideologies and power relations; to understand

private and public, global and local interactions; and to analyze the relationship between languages, people, communities and identities. Languages visible in a public space provide information about their use, status and spread; about possible differences between official language policies and real local practices. Official language policies and power relations between different groups can also be determined (Backhaus, 2007, p. 11). Linguistic signs could be helpful to understand the representations of minority languages as well as their co-existence with the state language. Thus, language use and visibility reflect the constant negotiation of various identities, ideologies, policies and practices.

In other words, linguistic landscape "refers to the visibility and salience of languages on public and commercial signs" (Landry and Bourhis, 1997, p. 23). LL is thus perceived as a public space that displays languages and consists of varied discourses and types of genre, which are typically characterized by multimodality and multilingualism. At the surface level, public space may seem to offer an open area for versatile language exposures, but in practice it often turns into an arena of ideological and political struggle for ownership of space, representation and control (Ruzaitė, 2017). Display of languages are often predetermined by a variety of linguistic, economic, political and other factors. It also has to be mentioned that linguistic landscaping is a dynamic process; therefore, it is interesting to observe linguistic landscapes of post-soviet places for identifying essential changes. As Du Plessis (2010, p. 74) states, "a change in regime can bring about a change in the linguistic landscape". LL focuses on urban sites since modern cities are mostly multilingual and reflect the global trends of the new economy and commodification of social and cultural phenomena. Moreover, cities exhibit competing powers of local and global, including language policies and practices. From this viewpoint, Visaginas has its own justification. The language situation there indicates the changes in the city, shows the representatives of diverse population, and might serve as a laboratory to focus on the issue of how different forces conflict or coordinate their attitudes (Shibliyev, 2014). The function of English, as a global player, is interesting to observe as well because the power and prestige of Russian is still dominating the locality.

## Language Policies, Attitudes and a Sense of Belonging

During the soviet times Russian was dominant as a language of soviet ideology and a promoter of "brotherhood". Since the restoration of independence, the sociolinguistic situation has been gradually changing as a state language, Lithuanian, is compulsory in the public sector. However, despite serious


**Fig. 2:** Graffiti in the residential area of Visaginas (Stop NATO. No war)

attempts to rearrange the linguistic landscape of Visaginas, Russian is still actively used in a private sector as well as in everyday communication.

There are many reasons for slow changes in this city. Scholarship on Soviet period immigrants to the Baltic States stresses the challenges of integrating this population into the social and cultural life of local societies (Vihalemm and Siiner, 2011). Russia, as the "country of origin", pronounces its concerns for its compatriots abroad and encourages "the maintenance of ties and Russian speaker identification with Russia as homeland" (Birka, 2016, p. 219). Recent events in Ukraine have demonstrated Russia's plans to protect and support the Russian language and culture of its compatriots living abroad. The awareness of complex relationships between social integration and feelings of belonging could provide a better understanding of identity transformation in Visaginas (see Fig. 2).

In this context of geopolitical events, Visaginas becomes a platform for negotiations of diverse ideologies and identities. The challenging feelings of belonging and attachment to the country of origin vs. country of residence are sensitive for the population and require a subtle approach. Therefore, it is quite clear that Lithuanian government is concerned about the loyalty of the Russian-speaking population and its attachment to Russia. The interview data show that Russian speakers in Visaginas favor integration over assimilation (for similar results in Latvia see Pisarenko, 2006); therefore, they uncompromisingly continue to cultivate their culture and use Russian extensively in all domains. They also explore different media platforms, predominantly in Russian. However, they admit the need to know Lithuanian, and research has shown that the competence of Lithuanian today is higher than ten or so years ago, especially among the young population (Lichačova, 2014).

The sociolinguistic situation in this city is quite complex. Despite governmental attempts lasting for thirty years to financially support language teaching, organize Lithuanian classes for adults, and introduce more hours of Lithuanian at schools and kindergartens, residents of Visaginas, especially older ones, still show quite poor competence of Lithuanian and prefer to speak Russian privately and in public. The issue is not only of a linguistic nature – the overall societal disappointment and the feeling of helplessness is obvious:

> *"three times I was attending Lithuanian courses. But they teach us about grand dukes, what they dream, but not the language. People are tired, stumbled, do not see any sense to study it for the fourth or fifth time"* (74, female).
> "*if then someone has been told us that we need to study Lithuanian or even other languages, that languages are important for a person, for his or her development, we did not know that…"* (72, male).

Even though elderly people claim that the age is an obstacle to learn Lithuanian, they also admit that the situation has changed now and the pressure is not so high as it was right after 1990, when "*only in one night we had to start speaking Lithuanian*" (70, female). Overall, the older Russian-speaking generation has developed more positive attitudes toward Lithuanian but have difficulties speaking or even understanding Lithuanian. They have mentioned bad memories of the attended language courses, poor quality of teaching materials and teachers' competence as non-motivating factors for learning.

Additionally, the most important factor for learning the language – the environment – was mentioned by the majority of respondents as well: "no one to talk to in Lithuanian" – that is the expression often mentioned during the interviews. Most of the informants mentioned poor motivation to study Lithuanian, as Lithuanian linguistic environment for them is very limited:

> *"Visaginas is a very closed town. It is closed because of the inability to communicate in Lithuanian. It is like a cage*" (55, female)
> *"Motivation to study Lithuanian should come from the pressure of the environment; however, that pressure is experienced when people from Visaginas go to other places in Lithuania, but not here"* (46, female).

It is clear that social networks among people in Visaginas are mainly with Russians; therefore, communication takes place only in Russian. Those who cross the border of Visaginas have both the advantage and pressure to learn Lithuanian:

> *"I like Visaginas very much. I go to Vilnius very often and I come back here.. . .. I go to Vilnius every week as I have to arrange many things related to the performances and other business. And I have very good friends there…"* (46, female).

The social networks approach (see Milroy, 1987) indicates that population groups having relatively many contacts with neighbors and only few contacts with outsiders use primarily the language their neighbors are using because they are less exposed to other languages. Clearly, the Visaginas case confirms this. Unfortunately, the town is still a very closed place and its residents rarely go to other places in Lithuania; therefore, they are not encouraged and motivated to advance their Lithuanian.

Despite the many issues, including linguistic, the positive attitudes toward Lithuania were observed in the data of older respondents as they seem to be reconciled with the present situation:

> "*my children and grandchildren do not live here. One daughter is in London now. They are speaking English very well (…) and Russian. My grandchildren know Russian and we speak in Russian with them (…). But we don't want to go anywhere. We like Visaginas*" (76, male).

Younger people's attitudes toward Lithuania and the EU are even more positive, mainly due to pragmatic reasons, such as favorable social welfare and political security. A Lithuanian passport is important for young people as it allows them to travel and work in many European countries (Labanauskas, 2014). This possibility enables young people to leave Visaginas and choose other places as their homes.

The respondents for the most part regard Russia or other countries of origin (the post-Soviet space) positively as well. Moreover, all survey participants are willing to rediscover, maintain and transmit their ethnic cultures, languages, histories and traditions to their children and grandchildren. The participants of diverse ethnicities have expressed their high motivation to discover their own roots. They engage in various cultural activities organized by their ethnic communities and organize Saturday schools for children to teach the heritage language. The motivation to re-separate from the Russian cultural space and rediscover their own ethnicity, culture and language was mainly expressed by the Kazakh, Uzbek and Ukrainian representatives; likewise, other ethnic minority groups are very active as well (see Visaginas cultural center/minorities). Their enthusiasm to discover and promote their own ethnicities, however, are limited to folklore, authentic cuisine, crafts and some language classes; but this is only a symbolic action because they all navigate in the Russian informational space, and the Russian language still remains the only language of communication:

> *"We all came here with the same aim, to build an atomic plant, to live and work here. We came from different parts of the Soviet Union and nobody cared what your*

*nationality is or if you speak another language. We all spoke Russian, and we speak Russian now….[..]. Everyone was in good relations with the others, we lived in peace… […].*" (79, female).

The concept of "ethnicity" was not important in the Soviet period, and the leitmotif of "druzhba narodov" ("friendship of nations", "brotherhood") and unity still dominated the interview data:

*"We live here, we spent here all our life, we raised our children here. We like Visaginas, its nature, people. …. It's our home*" (60, female).

Despite mainly positive attitudes toward Lithuania and Visaginas as their home, the respondents indicated disappointment regarding many aspects of social, economic and political life in the country. It is important to note that most of the residents follow political processes in Russia and consider the Russian language as a global language worth knowing and learning.

The long-term, strictly state-promoted, mono-ethnolinguistic (Lithuanian) approach, where "integration" means "assimilation", seems to be hardly applicable in Visaginas. The language situation adds even more complexity to the place. Although Russian is dominating, the reality of the place is a linguistic triangle: Russian – as a language of the dominant Russian-speaking community, Lithuanian – as an official language (but rarely used), and English, both a symbolic sign and a possibility to be part of global exchanges. The linguistic landscape demonstrates that official written signs are mainly in Lithuanian, private signs are bilingual (Russian – Lithuanian or Russian – English), but the spoken language is predominantly Russian (see Fig. 3). The level of formality of social space defines the use of the Russian language: if the social environment is less formal, then Russian is used; formal environments require Russian speakers to use Lithuanian (Labanauskas, 2014). However, this does not happen often as Lithuanians change to Russian when communication in Lithuanian is impossible.

The urgent question today is how to deal with the Soviet legacy: should the teaching of Lithuanian as the main language of all domains be promoted and strengthened? Or should bilingual or just Russian dominating linguistic practices be maintained? There is no one clear-cut answer to this complex issue. However, offering a different perspective toward Russian and the soviet heritage of the place might be useful if we view language and culture in the time of late capitalism as commodity.


**Fig. 3:** Bilingual signs of Russian-Lithuanian or Russian-English in Visaginas in private domains

## Language, Authenticity and Commodification

Today Visaginas is in the active process of developing its new identity. Different ideas and approaches are put forward by diverse stakeholders, from the de-ideologized scenario of the "city of happiness, youth" or "green city" to a very clearly articulated project as the city of "socialist atomic past". The idea "to sell" the soviet past is actively discussed and promoted not only by the residents of the city, but especially by outsiders. The concept of "heritage tourism" mainly refers to the consumption of historical and cultural heritage testimoning the past (Poria, Butler and Airey, 2003); it is also linked to the places, artefacts and activities represented by the narratives of locals and include cultural, historical and natural resources (Yale, 1997). Therefore, tourism in sociolinguistic peripheries urge local communities to rethink their cultural, political and economic conditions, and this involves the reconstruction of linguistic capital for the new and potential economic capital (Heller, Pujolar and Duchêne, 2014). The theme of identity is closely linked to the issues of heritage. In the context of global economy and tourism industry, Russian, as an identity marker for Visaginas, could be reexamined. Through museums and other heritage sites, tourists can be told the local story presented in such a way as to affirm and reinforce the place identity and self-image. The construction of identity is integrally bound to tourism discourses that seem to claim what we *are* (or *were*) (Baločkaitė, 2012, p. 41). However, the interviews have revealed that it is difficult to deal with the unwanted socialist past. Moreover, in the city there are only very few symbols idolizing socialism, while the official sites do not provide much information about them. Nevertheless, the past is hidden in social activities of everyday life that are hardly noticed by the outsider. The most

visible sign is the language. Therefore, as claimed by Heller (2010), multicultural and multilingual places are a great locality for heritage tourism to explore shifts in the role of language bound to changes in local industries and effects of the commodification of authenticity. Monika Heller and her colleagues define these changes as follows:

> *"Within a conventional neoliberal frame, peripheral language groups must learn to market themselves, identify the resources that can be commodified, and turn their rhetoric of political mobilization to one of marketable entertainment in complex and ambivalent ways. Thus, the sociolinguistics of tourism provides a window into understanding the emergence of new linguistically-invested forms of power which follow a logic of circulations and mobilities, and are in stark contrast with the cultural expressions of industrial capitalism, with its emphasis on territoriality and ethnonational belonging. The commodification of language and identity is then something fully consistent with the economic and cultural processes triggered by the globalized new economy".* (Heller et al., 2014, p. 561–562).

In this new social reality, the city is in transformation and search of its new identity. There are many examples globally when mono-industrial places go through dramatic changes of social transformation caused by the effect of the new economy. The global new economy is usually linked to changes in language and identities (Bauman, 1997; Castells, 2000) as well as tensions between local, national, supra-national identities and language practices, and between hybridity and uniformity (Heller, 2003). The sector of tourism could become a major industry for Visaginas generating economic value as economic development is a major driving force for the community and its well-being. In fact, language, culture and identity as authentic phenomena may play a significant role in this new transformation. The main characteristic of the globalized new economy is the commodified value of any kind of authenticity and exoticism.

Languages are very important for services, especially in the tourism industry. The increasing numbers of foreign and local tourists in Lithuania require multilingual competences. After the Baltic States declared their independence almost thirty years ago, the status of the Russian language significantly changed. For ideological reasons, the interest in studying Russian dropped and everyone started to learn English. This situation lasted approximately from 1990 to 2000. When Lithuania joined the EU, the walls opened boosting different kinds of mobility. The job market today often looks for employees who, in addition to English, know Russian (Dabašinskienė, 2011). The education sector sees the demand for the Russian language as well. We have been watching the dynamics of the choice of foreign languages in secondary schools for several years in a

row. Over 95 per cent of pupils choose English as their first foreign language, and the vast majority of schoolchildren choose Russian as their second foreign language. This motive is of economic character.

A number of different political and economic realities in the last decades have brought the Russian language on the world stage again. It became popular in the international service, especially tourism. Additionally, Russian today provides a valuable economic resource from the perspective of teaching and learning, as part of language commodification, revealing how promotion policies of learning the language can help individuals to advance language knowledge in order to meet demands of Russian-speaking tourists (Muth, 2017). Thus, we see that political discourses on national ideologies in the era of globalization, economic and demographic turbulences have changed the attitudes toward Russian-speaking tourists. Moreover, tourists from Russian-speaking countries (Russia, Belarus and Ukraine) are dominating Lithuanian incoming tourism. In this respect, we observe many strategies of commodification of the Russian language, which serves to attract and satisfy Russian tourists both locally (in Lithuania and the Baltics) and globally. Anette Pavlenko uses a special term "preferential accommodation" to explain situations where special arrangements are made for Russians, including simplification of visa regimes, acceptance of rubles, addressing in Russian and providing various media information services in Russian (Pavlenko, 2015). As business reacts fast, it ensures linguistic accommodation of Russian in the areas preferred by Russian tourists. Since Russian speakers can rarely communicate in other languages, services need to employ Russian in order to attract customers. The tourism industry reports the economic potential of Russian customers: in 2004, Russians were among the world's top ten biggest spenders, while in 2013, $53.5 billion spent abroad placed them fourth after tourists from China, the USA, and Germany (UNWTO, 2014). Tourism agencies and other tourism-oriented businesses (hotels, spa, restaurants, museums, opera houses, etc.) in countries popular with Russian tourists invest in Russian language resources and websites (e.g. http://www.visitlithuania.net/russia, https://www.visitfinland.com/ru/). They also hire a Russian-speaking staff; broadcast Russian TV channels; provide menus, newspapers, magazines, maps, travel guides and information about hotels in Russian; and in general demonstrate Russian-friendly attitudes. The developing tourism industry demonstrates that English does not always serve global needs. The arguments provided above suggest that for tourists who are ready to spend generously, local businesses have to invest into language learning (Pavlenko, 2015)

Thus, Visaginas could exploit the Russian language and soviet culture as a symbol of its authenticity. Tourist routes in Visaginas should focus not on such sites as museums, original architecture, symbolic objects, monuments, etc., but on the locality itself as an open-air museum displaying daily linguistic practices, routines, habits and attitudes, hidden and visible signs of the nostalgic soviet past, and atomic glory. Moreover, minority languages, cultures and identities could also be exploited, as they could become "means of production and [as] a product itself" (Heller, 2003). However, commodification of place, language and identity might be a challenge, as part of the community does not want their past to be "on sale". The tensions among different stakeholders regarding their vision for the city's future and its identity, from the "*city of green nature, happiness, youth to atomic tourism*", are discussed in recent publications (Mažeikienė and Gerulaitienė, 2018). Nevertheless, the locality with its mono-industrial atomic post-soviet heritage narrative could become an object of authentic experience, especially for heritage tourism. Russian as a symbol of that time also represents the reality of today. Its authentic practice in a linguistically homogeneous country offers a valuable possibility for a unique experience attractive for tourists. In the heritage tourism market, symbolic elements marking the authenticity of the place, including the language, may contribute to the city's higher potential. The elderly people of Visaginas envisage a great potential for their own memories, as they are "walking tourist guides":

> *"It's such a pity, I feel so sorry…There are so many interesting things here, and there still are people here who remember all the corners of this city. They know why this street is here, or where the first tomb is. There are so many places and stories to tell. About the first house, the first school. It would be so interesting"* (75, female).
> "*Visaginas is so rich, as there are so many diverse cultures, religions, folklore. People are so friendly. We celebrate great festivals that many people come to see (….). It is the best place to live, it is so tranquil, the nature is beautiful, there are many lakes where you can go swimming and enjoy boating…*" (68, male).

It is obvious that in the globalized new economy of services language skills become a crucial factor for the development of tourist infrastructures. Thus, even though Russian might play a unique role of practice-in-place and be attractive to Russian-speakers (or older population of the region), it is not enough; languages of other ethnic minorities, including Lithuanian and global English, could offer broader linguistic resources for communication with clients (see Fig. 4). Since multilingualism is becoming an increasingly important skill in the tourism sector, the multilingual capital of the community could help construct local authenticity and manage relations with clients.


**Fig. 4:** The poster inside the Culture center. Most of the informants declared their positive feelings to Visaginas, their hometown.

On this view, the dominance of Russian might be conceived not as an obstacle but as an asset helping to boost the economic potential of the tourism sector and other services. Therefore, the saying "Russian is everywhere" might be interpreted differently and attract visitors to explore the new-old reality of the locality.

## Conclusions

How individuals and societies cope with language and place identity in the contemporary world is an important sociolinguistic question which requires a critical analysis of linguistic practices, attitudes and understanding of the uniqueness of the locality brought about by specific historical and social circumstances.

Visaginas represents a rather peculiar place of hybrid identities, attitudes, feelings of anxiety, disappointment and hope. This is a unique place in Lithuania where diverse ethnic communities are still united by the Russian language and the feeling of "brotherhood". However, global tendencies and pragmatic attitudes toward one's future start making a difference, especially for young people. Prevailing discourses of a mono-ethnic nation state with a dominant state language create obstacles in giving rise to authentic multi-ethnic local identities in Visaginas. Language ideologies from a top-down perspective conflict with bottom-up practices and therefore require a more coherent, "softer" approach to Visaginas population. Most of the informants emphasize the richness of the city's culture, the people's creative potential, especially that of the young generation, which produces interesting projects and shows impressive

skills of entrepreneurship. The multicultural, multilingual and multiethnic profile of Visaginas is perceived by the informants as an important resource for representing the uniqueness of the town.

Due to its soviet past and a strong identification with the atomic power plant, Visaginas was unable to develop consistently after 1990. The strong pro-soviet attitudes and nostalgia for the heroic past (including the construction of the most progressive nuclear plant), the unchanged ethnic composition dominated by Russian speakers, and the intense use of Russian in everyday life make this site very remote both ideologically and geographically from the rest of Lithuania. For years, it was a success story and the place to celebrate socialism with a highly progressive mono-industry, desirable living standards and a notable quality of education. After the declaration of Lithuanian Independence in 1990, the town became the site of tensions and uncertainties. Visaginas did not become what it was supposed to become, i.e., a successful project of prosperity and flourishing. The feelings of nostalgia, emptiness, longing for intimate networks, lack of multilingual appreciation and a bitter failure to accomplish the soviet utopia were strongly reflected in the sincere stories of respondents.

The future requires transformation, but the process of changes is full of ambivalent ideas for the city's search of a new identity. Different stakeholders suggest different ideas for building the de-ideologized image of *young, happy and green city* with comfortable conditions to live and raise families. Additionally, the multicultural, multilingual and multiethnic profile of Visaginas is perceived as an important resource to represent the uniqueness of the town and deliver "commercialized hospitality" through cultural and recreational tourism. The opposite idea is to position the town as a socialist city within the framework of *socialist heritage tourism* with strong emphasis on nuclear identity. The latter idea looks quite promising for incoming tourism, especially from foreign countries, in the context of the rising movement of safe energy or desire for exotic experiences while visiting "dark" tourism sites, like Chernobyl. However, the official and institutional discourse of public authorities tries to minimize the socialist past in constructing the identity of the locality. How to proceed with the two ideas for commodification of the authenticity "soviet past, nuclear identity" vs. the de-ideologized identity of being "young/green" is a challenging question for the future of the city (Mažeikienė and Dabašinskienė, 2018).

This place is exceptional due to its ethnic composition represented by forty different ethnic groups. However, the situation does not indicate the diversity of languages. The opposite is true – the prevalence of Russian, as a soviet heritage, is dominating all the generations. The state has developed and offered many language programs in promoting and teaching Lithuanian; however, the

population of Visaginas, especially the elder, have not learned the language. It is obvious that the language policy introduced here was not effective and therefore failed. Unfortunately, during the thirty years of independent Lithuania no greater revisions of social, economic and linguistic policies regarding the issue of Visaginas were performed. A great number of researchers have highlighted the negative impact of top-down narratives and discourses produced by the country's politicians and journalists. These discourses, it is argued, hamper the integration process by creating incompatible identity positions between Russian-speakers and the majority (Cheskin, 2013). The attempt to remove the influence of Russian culture and various aspects of Russian identity will surely bring back discourses about marginalization and discrimination. Instead, policy makers should focus on making Lithuanian culture more accessible to Russian speakers. This research indicates that there is great potential for integrated, yet culturally distinct, Lithuanian-Russian or other hybrid identities. Indeed, a number of studies have shown that Russian speakers in the Baltic States consider themselves to be very different from Russians in Russia (Vihalemm and Masso, 2003; Zepa, 2006). Moreover, in the context of globalization and Europeanization the ethnic identity for Russian speakers does not seem to be a very valuable and important category, as young people mainly choose a pragmatic approach to their identification (Labanauskas, 2014). As pointed out by the informants, the most important factors for a successful life in Lithuania (if one considers this option instead of emigration), especially for youth and in the job market, were the knowledge of Lithuanian and social networks. The senior generation feels quite comfortable using only Russian, as there are no linguistic obstacles in communication due to the fact that "everyone here speaks Russian". However, they expressed fear for the future of the city, social insecurity for themselves and their children because the future development of the city is unclear.

The linguistic landscape and soundscape of Visaginas demonstrate varied linguistic resources of the city: from the dominance of Russian, as post-Soviet heritage; efforts to use Lithuanian, especially in formal sphere; and English in written signs. The attempts to manifest linguistic diversity as a social capital of the city are obvious and have good potential. Whatever changes in individual repertoires and group preferences will take place in the future, bilingualism at the level of society seems to be the most desirable outcome. In terms of the city's potential, it is obvious that the community possesses diverse linguistic and cultural resources to manifest multiculturalism. Any discussions related to language in place, according to Pennycook, reflect our understanding of

language as action: "What we do with language in a particular place is a result of our interpretation of that place" (Pennycook, 2010, p. 2).

Thus, the current situation of Visaginas can be assessed as the process of searching for the new identity and simultaneously adhering to the established linguistic routines, local habits and attitudes. However, the unclear present obligates the community to act and cater not only for local cultural and linguistic needs but also, following Heller and Martin-Jones's (2001) claim, to get ready to encounter the "new global forms of cultural, economic and social domination". The possibilities to explore soviet nuclear heritage are attractive for the tourism industry, so taking this route might create an added economic value and enable opening a new page in the city's life.

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# 3

Natalija Mažeikienė and Eglė Gerulaitienė

# Chernobyl Museum as an Educational Site: Transforming "Dark Tourists" Into Responsible Citizens and Knowledgeable Learners

**Abstract:** The chapter focuses on the concepts of dark tourism and disaster tourism, which could be viewed as a cultural representation of disaster. These tourist destinations provide visitors as potential learners with an understanding of the social, political and cultural causes of technogenic disasters. The chapter analyses what meanings of the disaster are created, how the disaster is constructed in the collective consciousness, and how social and cultural construction of the disaster takes place in media, popular culture, museums, and other cultural and social spaces. The cultural turn and cultural perspective on disasters allow understanding cultural framing of disaster, how disasters are framed and interpreted, collectively imagined, remembered and memorialised, represented and portrayed through folklore, songs, movies and other media (Webb, 2018). The exposition of the National Museum "Chernobyl" and the Chernobyl Exclusion Zone tours are viewed as specific versions of cultural and social representations of the Chernobyl disaster and can be related to and compared with cultural representations of Chernobyl in the media, films, literary and fine art works. The authors of this chapter conducted an ethnographic study of the exhibition of the National Museum "Chernobyl". The exhibition's overall space, the choice and positioning of objects, texts and labels were analysed. The exhibition was treated as a specific means of education and communication. The research aimed to carry out a study of the representation of the Chernobyl accident as a disaster by analysing verbal content, visual materials and symbols. The question was raised how the Chernobyl disaster is constructed in the Museum and what educational potential this disaster tourism destination has for visitors as potential learners.

**Keywords:** The Chernobyl Museum, educational nuclear tourism, dark tourism, disaster tourism, disaster studies, chronos, kairos, heroisation

## Introduction

Nowadays, Chernobyl is becoming an attractive place for tourists seeking exclusive existential experiences. Disaster attracts tourists because it conveys a specific sensory and aesthetic perception of the environment and landscape. The disaster place disrupts usual and enjoyable images of the landscape (Miller,

2007). It has a "high emotional impact" and is associated with death and other atrocities. Disaster tours are organised in areas affected by natural and technogenic disasters. Tourists' interest in this topic and trips to the Chernobyl area and visiting the National Museum "Chernobyl" could be seen as disaster tourism. Chernobyl is one of the largest human-made technological disasters.

The better understanding of the disaster tourism in the Chernobyl Exclusion Zone and the cultural construction of disaster at the National Museum "Chernobyl" was made possible by referring to ideas and approaches presented in disaster studies. This cross-disciplinary field views disasters as a social and cultural phenomenon, when disasters are presented through the cultural imagination, cultural representations and meanings of disaster (Holm, 2012). Disasters are not just a physical reality phenomenon where society and landscape undergo physical harm. Disasters are social disruption. Therefore, the disaster should be viewed as a social and cultural phenomenon when it is analysed in terms of what meanings of the disaster are created, how the disaster is constructed in the collective consciousness, and how social and cultural construction of the disaster takes place in media, popular culture, museums, and other cultural and social spaces. According to Webb (2018), the cultural turn and cultural perspective on disasters allow understanding cultural framing of disaster, how disasters are framed and interpreted, collectively imagined, remembered and memorialised, represented and portrayed through folklore, songs, movies and other media.

Referring to this concept of cultural perspective on disasters, the exposition of the National Museum "Chernobyl" and the Chernobyl Exclusion Zone tours are viewed as specific versions of cultural and social representations of the Chernobyl disaster and can be related to and compared with cultural representations of Chernobyl in the media, films, literary and fine art works. In this sense, disaster tourism is associated by visitors with other cultural experiences of the Chernobyl disaster (reading books about this disaster, watching films, following the discourse in the media).

## The Cultural Construction of Disaster in Tourism Destinations

The cultural turn in analysing a disaster allows delineating forms of collective representations and "myths" of disasters. Holm (2012) distinguishes several historically stable symbolic forms of how disasters are imagined and represented. One of the cognitive schemes of how a disaster is perceived is *sublime* as a specific aesthetic sense experience about the terrible, awe-invoking beauty of disasters; it is 'the violent sense experience overwhelming the observer who,

stricken with terrified dumbness and bodily stupor, experiences a masochistic blend of pain and pleasure' (Holm, 2012, p. 24). The cultural symbolic form of *trauma* represents the disaster through images of people's psychic health threatened by a "shock" or "post-traumatic stress syndrome". One more form of the collective representation of a disaster is a "*state of emergency*" which focuses on the breakdown of legal and normative structures caused by a disaster with possible reference to asocial behaviour and social chaos. The collective representation of *apocalypse* represents a disaster as the end of the world. According to Holm (2012), when we perceive a disaster through the cognitive scheme of *imbalance* and sustainability which was developed mostly by the ecological movement, we focus on the imbalance between human and biophysical systems causing disaster. Other cultural representations of disasters are associated with the idea of God and with theological and mythological images of the disaster as caused and influenced by god, evil and fate. The cognitive scheme *the blessing in disguise* constructs the disaster as "world fire" and "purification", the ground for new growth. *Theodicy* represents disaster as an expression of the gods' justice and will.

Disaster tourism and other cultural representations of disaster allow tourists understand the social aspects of the disaster, how the disaster affected people's lives and how social structures are related to the disaster. This aspect of social structures is analysed in disaster studies, where, in addition to cultural representation of accidents, disasters are viewed from a structural perspective when analysing their impacts on social structures (how they are disrupted and their functions are distorted) and how these social structures respond to large-scale systemic disruptions; also, how these social structures respond to large-scale systemic disruptions (Fritz, 1961; Kreps, 1989, as cited in Webb, 2018). Visitors to disaster sites and people who get to know disasters more closely through cultural activities and tourism become familiar with the structural approach which reveals how organisations (police, army, fire departments and special emergency divisions) and communities mobilise response efforts, adapt their structures, alter their tasks and create new response-related tasks to meet the demands of disasters (Webb, 2018).

Authors analysing cultural representations of disasters emphasise the role of culture as a source of resilience that protects communities from the impacts of disasters since it helps to make sense of the world (Webb, 2018). Disaster tourism can help understand how communities have tried to cope with disaster by creating the meaning. Disasters are viewed not only as physical damage, but it is also a disruption of social meanings when a vacuum of meaning occurs, when meaninglessness or absurd opens. Therefore, it is very important to find cultural

tools to create meanings that provide the basis for resilience during the disaster and in the post-disaster period. A disaster is viewed by disaster studies as a cultural phenomenon when disaster-stricken communities go through processes of social reconstruction, regeneration and recuperation; when new values and norms, new disaster communities and subcultures emerge in the disaster and post-disaster environment (Ibid). The authors writing on Hurricane Katrine's Disaster Tourism in New Orleans emphasise that this tourism aims to expose tourists to revival, recovery, the signs of hope and rebirth rather than a decline (Miller, 2007).

In this context, it is important to recognise how disaster memorials take place and how they play a significant role in the process of recovery from a disaster (Eyre, 2006). Cultural representations (memorials, museums, tourist routes, films, books) are dedicated to memorialise a disaster, pay tribute to victims and recount stories of loss and heroism, revealing the response of social structures to disasters and giving us a better understanding of how social and political structures worked during and after the disaster.

Moreover, one of the more important aspects analysed in disaster studies and what can be learned and discovered by tourists and visitors in disaster tourism is an understanding of how the technogenic disaster emerged, how society and culture became the cause of the disaster. Webb (2018), discussing cultural perspective on disasters, mentions the role of culture as a source of vulnerability. "The origins of disaster lie not in nature, and not in technology, but rather in the ordinary everyday workings of society itself" (Webb, 2018). Referring to the topic of causes of catastrophe, questions are raised who is to blame; what caused the disaster; what social, political institutions; and what social and cultural values determined it. In that regard, it is explored what behavioural patterns, values and attitudes of individual social and political structures, organisational cultures led to a disaster. It is analysed what social structures, organisational cultures have been dysfunctional, dangerous. Such disaster-inducing behaviour may have been of structural secrecy, whereby certain institutions and socio-political structures concealed information or provided misinformation; knowledge and materials may not be intentionally concealed but ignored or neutralised because different units or departments failed to communicate (Vaughan, 1999, as cited in Webb, 2018). Disasters may have occurred even though socio-political systems, organisations had their lack of imagination and their "failures of foresight", which lead them to underestimate the potential (Turner, 1976, as cited in Webb, 2018).

Thus, based on disaster studies, disaster tourism could be viewed as a cultural representation of disaster, which can provide visitors as potential learners

with an understanding of the social, political and cultural causes of technogenic disasters. Disaster tourism has the potential to evolve into environmental, social and political sciences education, i.e., to teach people how to think about society, culture and structures that create risk, lead to disasters.

The authors analysing dark tourism also highlight its educational potential. The main difference between heritage tourism and dark tourism is that the latter is often associated with some atrocity (Sharpley & Stone, 2009). By their nature, dark tourism sites, museums can elicit strong emotional reactions (Seaton 2009; Weaver et al., 2017; Podoshen, 2013). Broadly, the term refers to tourism focused around sites of death and suffering. The "darkest" tourism sites are generally solemn and highly sanctified places of actual suffering where ideologically mediated narratives serve instrumentally to attract empathy, contemplation and transformation (Weaver et al. 2017). The idea of the "aura", or emotion or mood conveyed, is an important theoretical construct in dark tourism (Seaton, 2009). Even though travel to places associated with death, disaster and dark tourism is not a pleasant experience, tourists are now more knowledgeable, critical, highly selective, highly segmented and more discerning than they were (Wu & Cheng, 2018). It is difficult to understand the essence of why one undertakes what may be unsettling, awkward, contestable or unpleasant experiences, but we still find in the existing literature that learning and education, as per Biran, Poria, and Oren (2011), Preece and Price (2005) and Kang et al. (2012), are situated as primary motivators. As Grebenar (2018) states, dark tourism sites must offer tourists the chance to consume death within the accepted boundaries of modern tourism and taste (Young & Light, 2016; Stone, 2012) whilst simultaneously facing the elements of taboo relating to death in our society (Stone, 2012; Stone, 2009). Dark tourism sites afford an opportunity to "write or rewrite the history of people's lives and deaths, or to provide particular (political) interpretations of past events" (Sharpley & Stone, 2009, p. 8).

The study of Wu and Cheng (2018) proposes eight constructs from the perspective of dark tourism research: participation, innovation, experiential risk, experiential memorability, experiential satisfaction, experiential trust, experiential involvement and supportive intentions towards dark tourism sites. There is a base of literature which explores dark tourism as a distinct phenomenon, including concepts such as site presentation (Yoshida, Bui & Lee, 2016; Friedrich & Johnson, 2013), heterotopia (Stone, 2013) and commodification within tourism (e.g. MacCannell, 2011; Sather-Wagstaff, 2011) and, specifically, dark tourism (Seaton, 2009).

The study "A Dark Tourism Spectrum" by Stone (2016) provides observations and research on dark tourism products which are multifaceted, complex in design and purpose and diverse; it is perhaps clear that the universal term "dark", as applied to tourism, is too broad. Therefore, it is perhaps prudent to argue for an analysis that accounts for multiple shades of dark tourism, concerning identifiable product traits, characteristics and perceptions. Stone (2006) distinguished seven classifications of dark suppliers along the dark tourism spectrum (darkest to lightest) (see Fig. 1): from the "darkest" – sites of death or suffering with an educative and historic approach alongside a strong authenticity of product and location – to the "lightest" – sites associated with death or suffering with an emphasis on entertainment.

Miles (2002) proposes there is a crucial difference between sites associated with death and suffering, and sites that are of death and suffering. So the experience and education at the Chernobyl zone is conceivably darker than the one at the National Museum of Chernobyl in Kyiv. As a result, questions have been raised about the distinction between authentic and inauthentic history. Indeed, one of the main contentions is how "dark sites", such as the Chernobyl zone, with a dominant commemorative ethic are portrayed as real, whilst it is more and more linked with a commercial orientation and a tendency to seemingly romanticise and thus distort past dark deeds. Since a diverse and fragmented set of dark tourism suppliers exists, so equally diverse are the motives of tourists who visit and consume these products. A recognised and structured framework of dark tourism supply is required to aid the identification and subsequent research of potential visitors and their experiences to these dark tourism products.

According to Miles (2002), a "darker–lighter tourism paradigm" does indeed exist; he suggests that dark touristic sites must engender a degree of empathy between the sightseer and the past victim (or product). He has it that recent death and tragic events that may be transported in live memory through survivors or witnesses are perhaps "darker" than other events that have descended into the distant past. Thus, those dark events which possess a shorter time frame to the present, and therefore can be validated by the living and which evoke a greater sense of empathy, are perhaps products which may be described as "darker" (Miles, 2000).

## Methodology of the Research

The authors of this chapter conducted an ethnographic study of the exhibition of the National Museum "Chernobyl" in January 2019. The exhibition's overall

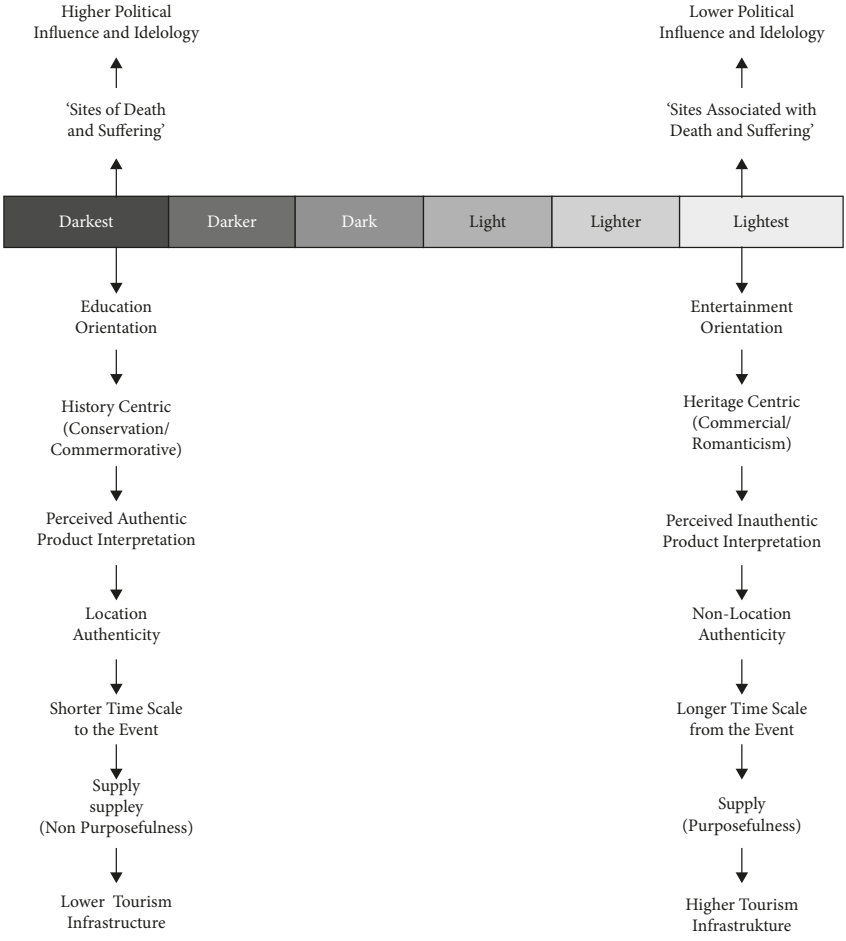


**Fig. 1:** A Dark Tourism Spectrum: Perceived product features of dark tourism within a 'Darkest–Lightest' Framework of Supply by Stone (2006)

space, the choice and positioning of objects, texts and labels were analysed. The exhibition was treated as a specific means of education and communication. The research aimed to carry out a study of the representation of the Chernobyl accident as a disaster by analysing verbal content, visual materials, symbols. We have been raising a question of how the Chernobyl disaster is constructed in the Museum and what educational potential this disaster tourism destination

has for visitors as potential learners. We acknowledge the limitations of this research object and field: we conducted the content analysis of the exposition and grounded on our insights regarding a potential educational effect. This analysis does not refer to interviews and conversations with curators, educators and other staff of the Museum. Moreover, this investigation did not encompass our analysis of educational programmes delivered by the Museum as well as assessment of the educational demand by visitors. We leave the description of these elements of Museum's activities and research on them to further investigations conducted by us and other authors in the future.

## Chernobyl Museum as a Disaster and Dark Tourism Destination

**The disaster.** On the 26th of April 1986, at night, a disastrous accident happened in reactor 4 of the Chernobyl nuclear power station in Ukraine, the Soviet Union. The radioactive fallout that leaked out from Chernobyl spread over large parts of Europe. Following the winds, it reached Belarus, Sweden on the 27th and 28th of April. The increased level of radioactivity was first recognised at the nuclear power plant in Forsmark, Uppsala county, Sweden. At first, the source was suspected to be within Forsmark, but the Soviet news agency TASS confirmed the Chernobyl accident in the evening of the 27th (Hultkrantz & Olsson, 1997). On the 18th of May, the World Health Organisation, the WHO, declared that the accident in Chernobyl would have no medical consequences to people outside the Soviet Union. Already on the 7th of May, the WHO declared that radiation in Europe, except for the area in the immediate neighbourhood of Chernobyl, was of no danger to people's health. However, the papers reported that, in spite of that, tourists outside Europe cancelled trips to Scandinavia and other parts of Europe. The explosion destroyed the reactor number 4 at Chernobyl, killing two plant workers that night of the accident, and, further, 28 operators and fire-fighters died within 5 weeks as a result of acute radiation sickness (WNA, 2012).

In the aftermath, up to 600,000 people, including soldiers, miners, plant workers and fire-fighters from all across the former Soviet Union – referred to as "liquidators" – were drafted in to decontaminate the site. P. R. Stone (2013) named Chernobyl post-apocalyptic place and analysed the number of deaths attributed to the disaster, which is still growing, partly due to lack of accurate records and politically contested criteria to determine Chernobyl-related mortality; a Greenpeace report suggests approximately 270,000 cancer cases within the affected region have been caused by the accident (Greenpeace, 2006).

Greenpeace also concludes that since the disaster, 60,000 people in Russia and 140,000 people in Belarus and Ukraine have died as a direct result of the incident. Stone (2013) examined reports on ongoing health impacts of Chernobyl and argued that radiation from the disaster had had a devastating effect on survivors, including the clean-up workers ("liquidators"); damaging the immune and endocrine systems, leading to accelerated ageing, cardiovascular and blood illnesses, psychological disorders, chromosomal aberrations and an increase in foetal deformations (Greenpeace, 2006). In 2011, the 25th anniversary of the disaster, the Ukrainian government sanctioned official tours to the site as well as to the abandoned "ghost town" nearby, Pripyat. Arguably, therefore, Chernobyl has become a destination associated with dark tourism and the "darker side of travel" (Sharpley and Stone, 2009; Stone, 2011).

**The Museum.** The National Museum "Chernobyl" is a multifunctional institution combining scientific, cultural and educational activities with a modern museum and archive, documenting, preserving and conveying the history of the Chernobyl nuclear disaster as the most severe radioecological disaster of the 20th century. The after-effects of it have no analogy and differ from other natural or human-made catastrophes. The museum opened to the public on the 26th of April 1992 in Kyiv, the capital of Ukraine, 150 kilometres away from the epicentre of the disaster. The current exhibition of the Museum has three exhibition halls with a total area of 1,100 square metres and more than 7,000 exhibits; there were only 200 exhibits in 1992. Large number of exhibition items, classified documents, maps, photos, special equipment, printings of that time, historic relics from the Exclusion Zone and other authentic materials, that are calling for reflections about the most burning problems of today's life and about ecological, social and spiritual consequences provoked by the Chornobyl disaster. Numerous records testify liquidators who sacrificed their health and even life, demonstrated courage and heroism to save the Earth from a global catastrophe. The Museum strives to become the centre of education of ecological culture, the culture of a safe life. Traditional tours, ecological lessons-excursions, lectures that aspire for new knowledge, conferences for those who are testing their own erudition, seeking answers to a controversial problematic question are organised at the Museum; moreover, ecological holidays are arranged as well.

The Museum exhibits modern audio and video records, information technology, allows expanding the chronological and thematic boundaries of the Museum and ensuring the authenticity of existing exhibitions. It presents a three-phase diorama "Chernobyl Nuclear Power Plant before and after the Accident", work model 4 of the power unit, an electronic book of Chernobyl

liquidators, unique documentaries, computer programs on disaster and its consequences. It is claimed that emotional and philosophical art devices are very important in the exhibition. They bring their message and help them understand the 20th-century global tragedy. The idea of creating such devices is the result of collaboration between Museum scientists and artists, inspired by expeditions to the exclusion zone.

The function of the Museum is not only to document history, but also to mobilise sentiments and evoke emotions which range from anger to pride. In other words, strong emotional reactions result from the visit to the Chernobyl Museum because it has expressed feelings of sublime and fear (for what happened and can happen in the future), sorrow, sympathy, depression and appreciation (for the peaceful present), and doubts about the future (energy and environmental concerns). This potential of museums to evoke complex and contradictory feelings is illustrated by the Chernobyl Museum's motto "Est dolendi modus, non est timendi", which welcomes the visitor at the entrance of the exhibition. Translated from Latin it means "suffering has its limit, but fears are endless".

**The education at the museum.** Museums and other historical sites could be presented as institutions that preserve, interpret and memorialise the past and suggest pedagogical strategies for different groups of learners. Museums are sites to learn about history, geography, biology, citizenship education, ethics, literature, philosophy and other subjects of the formal curriculum. Museums offer opportunities to promote learning of different subjects taught in the school curriculum. The artefacts they display, narratives they tell and re-creations of the past they exhibit potentially engage students with content in ways unavailable through classroom activities or textbook reading (Marcus, 2007). The site such as Chernobyl Museum may develop students' historical empathy by allowing them experience the history and make personal connections to people. Museums also create opportunities for students to think critically about the past and history as a discipline by analysing how museums interpret and present the past; and this construction is subjective, evolving and influenced by many factors. Visiting museums as part of educational experiences is critical because, long after students finish their formal education, they will continue visiting and interacting with the past at museums and memorials. Thus, facilitating students' skills in interpreting and understanding museums and memorials is essential (Marcus, 2007).

The official website of the Chernobyl Museum (http://chornobylmuseum.kiev.ua/en/about-us/) states that the museum aims to become an educational centre to teach about environmental issues and promote the culture of an

environmentally safe life. Efforts of specialists (teachers, scientists, scholars) of Ukrainian and public organisations from all over the world are put together developing various educational and socio-cultural programmes for all types of visitors.

## Construction of the Nuclear Nation and Nuclear Belonging at the Chernobyl Museum

The Chernobyl Museum creates a relation to the past; it is a site of memory, an imaginative reconstruction of the past. Memories are reconstructed through practices of storytelling. Museums contribute to the construction of the national identity by exhibiting and presenting national and cultural heritage by educating the public (McLean, 1998). This museum performs a memory work and, at the same time, negotiates and constructs meanings of the collective and national identity in presenting the Chernobyl event. It is a national museum, and, thus, in one way or another, reflects the state's memory policy in interpreting this historical event.

One way to construct a national identity is to instil a sense of national pride in their citizens. We discover this aspect at the Chernobyl Museum as the presentation and highlighting of the heroism of the liquidators, when the actions of the people involved in the emergency work are presented as heroic feats and are intended to exhibit commemoration of their heroic deeds, to pay homage and remembrance of the "Impossible Mission".

Based on the literature review, a tendency is recognised that nuclear issues are incorporated into the process of construction of the national identity. In this context, we would like to mention the Manhattan Project in the USA, which was devoted to atomic energy research into the creation of an atomic bomb, which later developed nuclear energy in the USA. Researchers (Masco 2006, Gerster 2013) point out that the Manhattan project has been an American nation-building project that began after World War II and was developed during the post-Cold War period and contributed to the "nuclear nation" and the formation of "nuclear nationalism". The Manhattan Project, an intensive tourist destination at present, introduces the atomic bomb-making process, providing knowledge of industrial nuclear heritage, yet at the same time giving shape to the perception that the country was a leader in entering the Atomic Age (Gerster, 2013).

The collective experience of Chernobyl becomes a significant element in the formation of the national identity in the post-Soviet period. The construction of the national identity during and after the Chernobyl event, which takes place

in a wider public discourse, also is represented in the Chernobyl Museum. The Chernobyl event itself became a marker and trigger for the collapse of the Soviet Union. The representation and narrative of Chernobyl were created already during the collapse of the Soviet Union and incorporated into the nation-building process of Ukraine, Belarus and other countries in the post-Soviet area. The identity structure of these countries can be recognised as "nuclear belonging" (Briukhovetska, 2016) when, on the one hand, several post-Soviet countries (Belarus, Ukraine, Russia) "inherited" nuclear weapons and nuclear testing sites (Semipalatinsk in Kazakhstan) before they belonged to the Soviet Union. Chernobyl as the worst nuclear reactor accident site (contaminated nuclear landscape) "belongs" to Ukraine, Belarus and Russia. These countries have become nuclear nations in this sense. In addition to the physical, biological and environmental consequences for these countries, Chernobyl is becoming part of the process of constructing a national identity. For Ukraine, it even has become a country brand, because of Chernobyl; this country is known to others and "appears" on the world map as a place of Chernobyl (Briukhovetska, 2016).

One important aspect of the Chernobyl experience as nuclear belonging is that it is a collective traumatic experience and memory. The "nuclear trauma", which as Briukhovetska (2016) has it, formed the core of the group identity. In the psychological sense (as individual and collective trauma) as well as in the cultural, symbolical sense (as "master signifier", "key symbol" and "myth"), the Chernobyl experience had to pass through a process of "nationalisation", to be integrated into the narrative of construction of the national identity. This collective trauma through memory work finds its expression in museums, fiction, cinematography and other areas of symbolical creation. The psychological and existential side of Chernobyl is presented in films, books and art projects.

The exposition of the Chernobyl Museum performs a function of citizenship education, since it presents a specific version of one of the largest and most significant events of the modern history of the nation. The exposition tells how divisions and participants (clean-up workers) of appropriate structures stopped and curbed the catastrophe, how they saved the world after the most terrible technogenic disaster in the world has happened. The idea of heroisation is also related to the idea of nuclear nationalism, when nuclear energy is treated as a national project, part of national history and shared collective identity of the nation. No doubt, the liquidators are introduced as "our heroes", not only as citizens of the Soviet Union, but also as citizens of our country (Ukraine) who sacrificed themselves for the wellbeing of the country, nation and entire humankind. Heroisation of the narrative on the Chernobyl disaster complies with the logic of creation of the national identity, when the history of the nation is being

created through the actions of heroes during the events which are significant to that nation. The heroisation prevailing in the narrative on the said disaster is a means to give meaning to the suffering and deaths of the liquidators, to assure that these deaths were not in vain.

In the process of the nation building, "biological citizenship" formed, the social-political, civic process took place, when citizens (especially Chernobyl sufferers) in the post-soviet Ukraine joined together for the process to fight for their rights (social protections and compensation as a form of payment for past damage), to employ bio-scientific knowledge (social statistics, radiobiology, health physics, etc.) to the aftermath's data-producingin the establishment of new policies guaranteeing safe living, social equity and human rights (Petryna, 2002). It was sought to create financial and moral obligations which would strengthen a national bond between sufferers and non-sufferers. Therefore, nuclear belonging and nuclear identity in post-soviet Ukraine formed not only as a group trauma, but also as a group civic process oriented towards an active political and civic action, implementation of own social rights.

Besides heroism, the Chernobyl Museum creates the collective and national identity through victimhood, when appealing to collective experience of the trauma, and the traumatic historical event becomes the basis for bringing the group, nation together. For instance, the Holocaust is treated as an experience and historical event bringing the nation together, as a historical trauma that brings together and "creates" modern Jewish nation, and museums dedicated to the Holocaust perform this role throughout the world. The National Museum of the Holodomor-Genocide in Kyiv, Ukraine, is also attributed to a similar construction of the group identity through group victimhood.

This creation of the collective and national identity through the victimhood complies with another example of the construction of the nuclear nation, i.e., building post-war national identity in Japan. The so-called atomic-bomb nationalism in Japan is promoted by creating the "victimization narrative" and unifying national feelings of suffering and being victims after defeat in the war (Schäfer, 2016). The educational tourism site at the Hiroshima Peace Memorial Museum as the atom bombing place plays an important educational role in citizenship and history education; it is considered as an essential element of the national project in constructing the collective memory and national identity in Japan. Additionally, the anti-nuclear stance and striving for peace is one more constituent element of the post-war identity in Japan, besides collective mourning and grief. These messages of suffering, the traumatic experiences of victims during the bombing and aftermath, anti-nuclear discourse and promotion of peace are strongly reflected in the part of the Hiroshima Peace

Memorial Museum which was built first and expresses a traditional approach in representations of history and identity.

## Epic Heroic Narrative in Commemorating Heroes – Clean-up Workers (Liquidators)

Considering the Chernobyl Museum's exposition, we recognise these two discussed conceptions (heroism and victimhood). The first idea deals with heroism, sacrificial actions of specialists and citizens who participated in liquidation of the disaster (clean-up workers-liquidators), helped ceasing the fire, stopped the spread of radiation and cleaned up the territory. On the one hand, this heroic construction of the narrative on Chernobyl meets the representations of heroism which are deep-rooted in the Soviet tradition of heroisation. On the other hand, representatives of the disaster studies mention heroisation as a typical strategy applied in cultural disaster construction depicting how social structures responded to large-scale systemic disruptions during and after disasters, how organisations (police, army, fire departments, special divisions) and communities mobilise response efforts, adapt their structures and alter their tasks, and create new response-related tasks to meet demands of disasters (Webb, 2018).

The major narrative line in the exposition halls 1 and 2 deals with occurrence of the teams of liquidators-heroes throughout the disaster event. First, engineers of the nuclear power plant, who were the first attempting to identify what was happening, to find out the actual situation of the disaster, appear. The first heroes were fire-fighters who were extinguishing the fire and underwent lethal doses of radiation. Later, other groups of rescuers joined in: these were miners, helicopter pilots, soldiers attending obligatory military service, who cleaned the reactor's roof from graphite, other officers, and civilians called in from military reserve to clean up the territory, construct the roof (sarcophagus). Scientists, physicians and other medical staff are also presented as the heroes. The presented heroism of the liquidators involves a dominating style of presentation of authentic details and documents. In this part of the exposition, a visual style of documents prevails; texts including facts, detailed descriptions, black-and-white photographs of the participants, images of the disaster and acting liquidators are presented; in single cases, documentary video recordings (for instance, rendering how soldiers using shovels are removing graphite from the reactor's roof), authentic details of liquidators' clothing and separate units of equipment are displayed. Besides photographs and descriptions of single participants (heroes) and groups of them, documents evidencing state awards

(letters of acknowledgement, medals), in single cases, information and related documents on undergone dose of radiation, degree of injury, and history of disease or death are presented.

Heroism of the liquidators is demonstrated and acknowledged by presenting many state awards for heroism (letters of acknowledgement, medals, honorific names of heroes) given to people-liquidators. These awards not only formally acknowledge and enhance the narrative of heroism, but also construct the relation between heroes and state which awarded them. At the same time, grounding on the critical perspective to construction of Soviet heroism, a question is raised whether the medals and state awards could be considered as sufficient expression of respect of the state in this case (if no other kind of support, i.e., treatment, social guarantees, and financial allowances, is given together with the medals). It is worth noting that, besides the awards, information on undergone doses of radiation and the fate of the heroes, many of whom died from the effect of radiation or are presently severely ill, became people with disabilities, is presented.

## Comparing Heroic Narratives of the Chernobyl Museum with Non-heroic Representations in Other Texts: An Intertextual Reading

Emphasis on the heroic discourse in halls 1 and 2 of the museum can be "read" and interpreted in connection to other texts, through intertextuality, when texts of the museum's exposition are read by collating them with widely publicly known and read (by creators and visitors) texts on the topic. Svetlana Alexievich's famous book "*Voices from Chernobyl: Chronicle of the Future*" (1999) is one of the significant texts making an impression and conception comparable to the exposition of the Chernobyl Museum. In this book, we find another, "non-heroic", conception of Chernobyl as a version of an experienced, undergone event, which became "a monument to suffering and courage", reporting traumatic experiences and exploring how these events affected the lives of people, representing the new human condition of the trauma (Marchesini, 2017). Working as a journalist and using collective testimonies about traumatic events for 10 years, S. Alexievich collected more than 500 interviews of witnesses, including fire-fighters, liquidators, physicists, physicians, politicians and ordinary citizens. Depicting Chernobyl, she deeply explores not the disaster as a sequence of historical facts and events (even though, while reading the book, we, readers, reconstruct the proceeding of the disaster and what happened aftermath); she is more interested in an existential and psychological

measure of this event – how people survive and "measure" this event by their existence, feelings, how they undergo suffering and losses, what psychological and philosophical meanings they construct decades later after this accident. This narration is not heroic; participants of the accident are depicted as people who suffer from physical, psychological, existential pain, raise philosophical questions and tell their doubts about their self-sacrifice. In this book, participation of liquidators is testified by their wives narrating about liquidators' mortal suffering and death. The "non-heroic" narrative of S. Alexievich's book manifests in a way that the liquidators, participants of the event, see themselves not as heroes but rather as victims of the Soviet regime and radiation, tell how absolute majority of them were called in and transported to the site of the disaster not by their will – specialists, members of paramilitary statutory divisions, army soldiers and reserve soldiers; many of them note that back then they did not understand, did not know and were not informed about the extent of radiation on the site (about obtained doses) and the effect on their health; how presently they suffer from diseases, were witnesses of many of their comrades facing "terrible, characteristic to the liquidators" death. The liquidators, their wives and relatives tell about the psychological and spiritual pain and suffering when watching physical pain (oncological diseases) of their children.

Besides S. Alexievich's book "Chernobyl Prayer: A Chronicle of the Future" (2016) emphasising not heroism but rather existential suffering, other fiction texts analysed in scientific literature as contrasting to the heroism-based narrative of Chernobyl and presenting the existential perspective to Chernobyl, how the Chernobyl disaster is experienced by the participants, through the existential perspective of their daily lives can be pointed out. A film "Innocent Saturday" (*V Subbotu*) released by a Russian director Aleksandr Mindadze in 2011 is analysed as a case of construction of the non-heroic narrative; in it, A. Mindadze depicts Chernobyl in terms of an "existential zone", through existential dilemmas, revealing the existential impact on ordinary peoples' lives (Lindbladh, 2012). This "existential action movie" depicts ordinary people struggling with their ambivalent and complex thoughts and feelings, wishes and fears. In the course of the entire film, the protagonist tries to escape from Chernobyl on the first day after the explosion (on Saturday) after he finds out about the disaster that happened earlier that night. The hero fails to leave Chernobyl; one can anticipate that he will suffer and finally die from radiation. The film avoids telling about the Chernobyl disaster from the perspective of the theme of Soviet heroism where heroic self-sacrificing deed and heroic death, the brave actions of Soviet people fighting against the catastrophe (Lindbladh, 2012), are depicted. The protagonist of the film is an anti-hero, who is trying to

escape from the place of the accident and fight against inner feelings, suffer the inner crisis. It should be noted that when the film was created it was not shown in Belarus because it was considered as an offence to the memory of the heroic deed of liquidators.

The above-discussed Chernobyl narratives present in the museum and other texts (S. Alexievich' book, A. Mindadze's film) reveal different strategies of construction of the collective identity while constructing the Chernobyl disaster. The museum more emphasises the tradition of heroisation; whereas other two mentioned fiction texts are oriented to existential representation of physical and spiritual suffering.

## Structural Approach to the Chernobyl Disaster: Learning How the "Soviet System" Worked

On the one hand, the strategy of heroisation is a way to commemorate participants, to express gratitude and respect to them. On the other hand, heroisation is a means of construction of the collective identity, when a disaster as a significant event becomes common experience of a group or a nation; it brings together residents and citizens to make one nation. Heroes and their heroic deeds create the present, the post-disaster world and the nation. Besides heroisation, the highlighting of the role of clean-up workers allows museum visitors understand how a disaster is presented from a structural approach, when attempts to understand and depict how social structures mobilised and adapted their tasks to meet demands of large-scale disasters (Webb, 2018) are made. In the case of the Chernobyl disaster, a visitor has an opportunity to perceive how the system of the Soviet Union whose resources were massively employed in response to this large-scale disaster operated. By seeing in the exposition that vast numbers of people who took part in the liquidation operation (over 350,000 male liquidators were involved between 1986 and 1987 and till 1992 totally 650,000 liquidators took part in the liquidation process), how many clean-up workers (fire-fighters, soldiers, helicopter pilots, miners, called in military reserve troops, scientists, physicians, etc.) in teams operated compatibly were organised and performed according to the system regulation, how much of materials, technical mechanisms and means were raised and utilised, visitors can have an impression and understanding of the general extent of the crisis and emergency management in the Soviet Union, when resources of impressive scale were allocated and retrieved from throughout the entire Soviet Union.

Together with the heroisation narrative, this moment may raise surprise in visitors due to the extent and scale of the entire action and process. Interesting to note that this narrative about high efficacy of emergency management in the Soviet Union is similar to representation in the HBO series "Chernobyl", where also a strong emphasis is put on depiction of heroic actions of teams of liquidators and demonstration of large-scale managerial, scientific and technical capacities of the Soviet Union allocated for liquidation of the disaster, paying less attention to the repressive and forced character of the emergency management model.

However, it is important to compare another cultural disaster representation, the text of S. Alexievich's book "*Chernobyl Prayer: Voices from Chernobyl: A Chronicle of the Future*" (2016), with the narrative of the Museum's exposition. The non-heroic narrative in the discussed Alexievich's book is developed by demonstrating the repressive operation of the Soviet system during the liquidation of the disaster. In this documentary book, former liquidators tell how they were called in (e.g. from military reserve) and threatened by court martial or other punishment, were sent under obligation to the site of the disaster. Others note that even when going by their own choice they, nevertheless, were impacted by the ideological system and cultural values as well as developed attitudes "to perform heroic deeds", "carry out significant deeds", "show/prove their masculinity", "to do civic duty" or simply could not act or think in other way than in line with that system and people of that (Soviet regime) time.

In the discussed book by S. Alexievich and the HBO series "Chernobyl" based on it, we find quite strong criticism of the Communist Party and the Soviet system, when the system is criticised for not providing information on the scale of the disaster and impact of radiation, protection measures (e.g. there was no information on the taking of iodine tablets) and compulsory mobilisation to the site of the disaster. Narratives and disaster interpretations in both Alexievich's book and series "Chernobyl" slightly differ from the narrative available in the Chernobyl Museum, where heroism of the liquidators is underlined, their self-sacrifice is presented as necessary, unavoidable and meaningful, there is much less of criticism expressed towards the local regime and party actions.

Comparing with these two texts (S. Alexievich's book and HBO series "Chernobyl" based on the book), the Museum's exposition does not provide any deeper and stronger criticism of the Soviet regime explaining why the disaster happened and how liquidation of it proceeded by employing a repressive mode of the system.

A museum visitor gets acquainted with the criticism of the ideological system of the Soviet Union at a lesser degree (comparing to the narratives of the

book and series on Chernobyl). Museum visitors have an opportunity to have a short insight of common cognition of the political and ideological context of the Soviet Union, when the scale of a powerful emergency management campaign is introduced; however, there is no introduction to the general ideological and repressive character of the system.

The regime of the Soviet Union is criticised at the beginning of the Museum's exposition by short information telling that the fault for the explosion of the nuclear plant was attributed by the Soviet government exclusively to the managing bodies and the dispatcher team of the nuclear plant as well as "the human factor in the management of the nuclear plant". The Museum's narration briefly introduces that the human factor as a problem of the actions of the nuclear plant's personnel and management decisions was identified both during the demonstrative trial of the causers of the disaster and in public explanation of the reasons of the disaster; whereas constructional drawbacks of the nuclear plant's RMBK reactor as well as general mistakes in development of nuclear energy science and industry were not publicly identified and recognised. A short text presented in the exposition highlights that the main fault for the accident was attributed to the team of the nuclear power plant without reasoning; whereas the drawbacks of the constructional reactor were not investigated and explored in public. To compare, we could mention the narrative of the HBO series "Chernobyl" where, in line with heroic depiction of liquidators' performance, much attention and major emphasis of the film is paid to showing how faultily the nuclear energy and nuclear energy science serving it operated. In this sector, scientific knowledge was being created under the conditions of strict control and secrecy. A belief in Soviet nuclear science allowing no errors ("Soviet nuclear reactors do not explode") was being ideologically constructed by scientists, party activists and citizens themselves. The systems of the Communist Party caused a specific interaction between party decisions (party nomenclature personnel), scientific knowledge (scientists), etc.

Nevertheless, the narrative of the Chernobyl Museum presents criticism of the Soviet regime when secrecy that covered the events of the disaster is revealed. The exposition of the hall 1 tells about the reticence of the fact of the accident and the true extent of the disaster by the Communist Party as well as hiding this information at both national and international levels. This narration is developed through exhibits, introducing the demonstration held on the 1st of May 1986 in Kyiv. The annual festive event dedicated to celebrate the 1st of May, the Labour Day, having high ideological significance as one of the largest celebrations of the year, was not cancelled to prevent from panic among residents and to demonstrate that the accident was secure to the people.

In such a way thousands of Kyiv residents (adults and children) were exposed to a very high level of radiation. Only nineteen days after the Chernobyl accident, Mikhail Gorbachev publicly announced the catastrophe. An impressive exhibit of the Museum contains two spread pages of a major daily issued on the first days after the accident, including a small part encompassing short, laconic information on the Chernobyl accident as a text telling that the situation is being managed and under control.

The Museum narration suggests that the news on the explosion was not publicised for international community, and local residents were not informed about the degree and extent of the danger and possible damage; there were no information and actions which would reduce the damage to the residents (e.g. information on affected territories, contaminated and forbidden for consumption agricultural produce). The Museum exposition dedicates a separate narration to the hiding of information from international community and other states that underwent radiation (Sweden, Finland). The Museum visitors find out the circumstances of how Swedish scientists at the nuclear-power plant in Forsmark, in Uppsala county, Sweden, discovered the increased level of radioactivity. The Soviet news agency TASS confirmed the Chernobyl accident in the evening of the 27th (Hultkrantz & Olsson, 1997). On the 6th of May, the Minister of Health of Ukraine informed the population that they took all necessary precautions for increased radiation. This announcement occurred only ten days after the explosion.

The Chernobyl disaster which contaminated Ukraine, large swaths of Eastern Europe, Scandinavia and neighbouring states was inseparable from the slow "social and political unravelling" of the Soviet Union (Petryna, 2002, p. 21). These facts which are exhibited in the museum have to be interpreted by visitors themselves, and this amplifies the importance of teaching interpretation and analysis skills to students. The 1986 nuclear disaster has come to embody the demise of the Soviet era not only in the way the accident itself contributed to the sudden implosion of the internally vulnerable Soviet system (Van der Veen, 2013), but also in the way that the Exclusion Zone today has become a frozen microcosm of late-Soviet everyday life (Davies, 2013).

Thus, expositions of the Museum reveal some important features of emergency management during disaster within the Soviet system – reticence, hiding and secrecy of vital information. Also, one can recognise a common feature of nuclear energy that was briefly pointed out, though not broadly developed in the Museum's exposition – secrecy, when information on the very objects of nuclear energy and smaller incidents as well as large-scale accidents taking place there is hidden, classified as secret. Scientists analysing history of the nuclear

energy (Brown, 2013) underline that knowledge of risk was a closely guarded in nuclear industry. Information was hidden in all earlier emergency actions, which had all played out in Ukraine before in 1951, 1953, 1955, 1957 and 1967 in the Urals. "The compartmentalization of information, the secrecy, the failure to inform the public of radiation dangers, the evacuations that occurred with critical delays, the deployment of expendable prisoners and soldiers on the most dangerous jobs, the failure to inform these "jumpers" and other employees of ways to protect themselves, the unpredictability of radioactive fallout in concentrated hot spots outside the neat zones of concentric circles – all were eerie repetitions of the plutonium disasters of the previous four decades. The only new feature in 1986 was that the catastrophe occurred while the cameras were running." (Brown, 2013, p. 285).

To summarise, the Chernobyl Museum provides knowledge on history, political sciences and sociology, and civic education. Analysing social and political context presented by the museum exposition, the students could get knowledge about the Soviet Union as a political, ideological system which praises itself for the controlled and managed most severe radio-ecological disaster of the 20th century. Visitors to the Museum learn about the Soviet regime, Soviet emergency-and-crisis-management system, technological, political, ideological aspects dealing with the nuclear energy industry. The Museum provides a rather weak critique of the Soviet regime in comparison with other abovementioned literary and cinematographic texts of Chernobyl. It amplifies the importance of teaching interpretation and analysis skills to students. Exploring the political and social contexts of how the Chernobyl Museum was created and maintained enhances students' ability to deepen their critical understanding of memory work at museums which is a part of broader processes of politics of memory. The Chernobyl Museum is a historical source that needs to be critically analysed and evaluated. Teachers can encourage a critical reflection of museums and memorials as interpreters of history and recognise the political, social and economic factors that influence them.

## Learning about Radiation in the Contaminated Nuclear Landscape

Environmental and nuclear geography are another learning subject represented in the Chernobyl Museum exposition. Nuclear geography includes critical geographies of nuclear energy, waste mobilities, nuclear geopolitics, or more-than-human interactions with ionising radiation (Alexis-Martin and Davies, 2017). The Museum exposition presents and describes the nuclear landscape in

the Chernobyl Exclusion Zone. Moreover, presented geography of nuclearity covers a narrative on how radiation has affected the territory of neighbouring states and Europe in general. The fallout from the accident covered 150,000 km2 of Europe, affecting Belarus, Ukraine and the Russian Federation in particular (UNSCEAR, 2000). Due to the enforcement of a 2,600 km2 "Zone of Alienation" (Зонавідчуження Чорнобильської АЕС) around the epicentre, about 350,000 people had to evacuate, and 2.1 million Ukrainians still inhabit the land officially designated as affected by the accident (Davies & Polese, 2015). The radioactive landscape of the Chernobyl Zone is a place of invisible danger. The nuclear landscape reverses the old adage "what you can't see, it won't hurt you" and blurs the boundary between "contaminated and safe", "seen and unseen", "formal" and "informal". As such, those living in Chernobyl-affected territories can be viewed as "bare life" (Agamben, 1998). The Chernobyl landscape is a place infused with contested meanings: for some, a rural idyll tarnished by the invisible spectre of radiation; and for others, simply "a place called home". Instead, they live on in the memories, photographs and everyday lives of those who call this nuclear landscape "home" (Davies, 2013). These efforts to treat nuclear landscapes as "used and lived in" (Cresswell, 2003, p. 280; Cram, 2016) offer reminders of the connections among bodies, homes, states and colonial networks – the uneven geographies of nuclearity. Davis and Polese (2015) point out that people's, who live in Chernobyl-affected territories, lives are stripped of the protection of the law and abandoned through insufficient welfare and compensation protection to an uncertain fate; their potentially damaged biologies are placed outside the responsibility of the state to face the hidden violence of abandonment (Davis & Polese, 2015).

The topic of environmental geography and health issues due to the nuclear disaster is presented in the second exhibition hall. The Museum presents artefacts, such as medical tools, equipment, photographs of physicians helping Chernobyl victims, medical records and personal belongings. There is a wide range of discussions on the scope of contamination of the uninhabited area, exclusion zone, cancer disease and how radiation affects human beings. The Museum exhibition provides knowledge on how high radiation in the contaminated zone caused mutations of animals: a skeleton of a newly born pig which has six legs is exposed. At the same time, there is some lack of information in the Museum on how the disaster affected nature, plants, forests and wild animals.

The exposition at the Chernobyl Museum dedicates part of the second hall to environmental issues, presenting the information about the people and territory which used to be "lived in" and the geographical history of the development

of the region in different centuries attracting people from all over Europe to live in and contribute to economic and cultural development of this territory. The map of the Chernobyl-affected territory is exhibited in the second hall with presentation of silent stories of people who lived there.

Their everyday life is presented as ceased moments that will never happen again. After the Chernobyl disaster, they became a nuclear community which shared the experience of radiation and became communities medically and economically affected by the disaster. These communities are being stigmatised for their association with a polluted place (Davis & Hayes-Conroy, 2017) or a sense of pride and resilience in their communal ability to survive in such an environmentally hostile situation (Davies, 2015; Stawkowski, 2016). A nuclear community is defined as any group that is associated with ionising radiation, which offers a significant scope for exploration of different perspectives, demographics and geographies (Blowers, 2016; Butler, Parkhill, & Pidgeon, 2014). Next to the map of the Chernobyl-affected zone, visitors can find an interactive display (see Figure 6), with the detailed information about towns and settlements devastated by radiation. This information could be an important learning material for geography subject, as it provides information about location and history of all towns falling to the Chernobyl-affected zone. The information includes the region of the town, the history, population at the time the catastrophe has happened and current situation, the date of evacuation, the place of resettlement, and the radiation background on the day of evacuation, including information on how many thousands of times it exceeded the acceptable norm and radioactive contamination comparing the data of 1986 and 2006.

Another interesting exhibit is situated in the third hall: it is a computer display demonstrating the material depicting the geographic trajectory of the radioactive cloud movement across Europe and the countries that have received high levels of radiation in ten days from the start of the disaster.

It is worth remembering that disaster studies deal with how a disaster affected communities of inhabitants not only physically, but also what that disaster meant to these communities in a social sense, how that disaster altered their social and emotional world and how the meanings are being created after the disaster. Usually, cultural representation of disasters presents how communities tried to cope with a disruption of social meanings during the disaster, how it went through processes of social reconstruction, regeneration and recuperation, how new values and norms, new disaster communities and subcultures emerge in the disaster and post-disaster environment (Webb, 2018).

In the Museum, quite many exhibits are dedicated to the nuclear communities: depicting how the disaster affected local residents; here, social aspects of

nuclear geographies are revealed. At the start of the exposition, at the entrance of the Museum, the villages and settlements of the Chernobyl Zone contaminated with radiation, no longer inhabited and abandoned by people, are displayed for visitors: 76 names of the towns and settlements where people lived before the explosion and disappeared from the map after the explosion; these residents were evacuated within 10 days. Several years after the disaster, 92 Ukrainian towns and 303 towns in Belarus were additionally evacuated.

The view of abandoned territories is presented in the initial part of the Museum (at the entrance) by using a metaphor of a road sign: hundreds of road signs with inscribed names of settlements hang from the ceiling at the entrance. These road signs are used for marking exit from a settlement (a name of a settlement in white on a black field crossed through with a red line). In its metaphorical form, this road sign means that these settlements are abandoned, uninhabited, there is nobody in there and there is no road leading to these settlements. In the third hall of the Museum, visitors find symbolical depiction of inhabitants and settlements affected by the Chernobyl catastrophe. A large part of the walls in this hall depict facades of empty, abandoned village cottages. Visitors are invited to feel the no-longer-inhabited area – this is the feeling which overwhelms when exploring windows of empty cottages, noticing absence of residents (hosts, women, children). The sense of abandonment and uninhabitedness is enhanced by neglected things (child bicycle and other belongings) scattered around. Here, one observes a specific resemblance (intertextuality) to the iconography of the Pripyat town how the town is depicted after evacuation of its inhabitants – toys left or scattered around in a hurry, household items showing signs of physical decay: broken, damaged, rotten, no longer needed to anyone.

## Existential Conceptualisation of Time at the Chernobyl Museum: Multiple Temporalities in the Interplay Between *Chronos* and *Kairos*

The construction of tourist's and visitor's experience is a complex process, like an exhibition, a museum, a tourist site, etc.; it evokes specific feelings, experiences and, in such a way, the co-creation of experiences proceeds. The museum presents the event-related memories which deal with understandings of time and temporalities. Going deeper into the understanding of the temporal structure of museums' narrative, one can find numerous temporal modalities. Analysing the construction of time in pieces of art, literature, cinematography, museum expositions, the time *chronos* and *Kairos* is singled out. These two

ancient Greek divisions of time allow to decide how temporalities intertwine in narrative, how tension evolves in them, which temporality prevails, which is expressed less.

*Chronos* means time which is measured as a sequence or an order; it is literally chronological, like in the passing of time indicated on a clock (Hannam & Ryan, 2019). *Chronos* means the quantitative experience of time; it is a sense and representation of time as the time of history, the narrative duration-time, the age of an object, event or person (Metcalfe, 2006). An exposition structured by a *chronic* articulation of the time is presented as a historical chronological sequence of events, as the homogeneous, orderly and seemingly objective flow of time (that is why *chronos* is measured and represented by clock and calendar). Time as *chronos* in specific modern understanding is presented and experienced in a linear manner – as a linear time with a sense of historical continuity. In comparison, in the Ancient concept, the time of history was represented as a cycle. The non-cyclical arrow-like trajectory of linear time normatively valuates future as progress (Hom, 2018).

*Kairos* refers to specific decisive and life-changing moments and turning points in time, it is a critical and decisive, "right" time to act, time that is taken or grasped, or a perfectly timed opportunity which has value (Hannam & Ryan, 2019, p. 2). The notion of Kairos stresses a sense of time as occasion and the opportunity to seize the moment and take timely actions. "*Kairos* meant appropriateness, timeliness, the right and judicious moment to act, the season or point in time at which something appropriate happens that cannot happen at any time, in other words, *kairos* involves a much more qualitative notion of time" (Metcalfe, 2006, p. 247).

*Kairos* is a kind of time of action to be accomplished, to a decision to be reached or to an initiative to be undertaken (Cipriani, 2013). These *karoitic* moments of possibility and taking an opportunity become interruptive in relation to *chronos* as continuity and flow of history. *Kairos* represents interruptive time as disruptive moments which can open the space for agential possibility, the capacity of individuals to act in a given context agency; *kairotic* interruptions have the transformative potential to subvert the *chronic* logics and continuity and open opportunity for agency of people, what is important in the time of crisis that requires a response or a decision to be made and an action to be taken (Winderman, 2017). The development of a unified global *chronotic* imaginary is frequently interrupted by *kairotic* considerations. Kairos allows us to see history as not simply "one damn thing after another", but as endowed with a trajectory and purpose. In "kairos", a unique event is seen to create, arrest or change time rather than endure it (Rao, 2019).

In some texts, the notion of *kairos* emphasises the centrality of the subjects' experiences, interpretations, understandings and narratives to the life-course or historical sequence of events. *Kairos* denotes experienced and significant time which may have an existential and sacred meaning (Cipriani, 2013). *Kairos* temporality reveals existential feelings and transformations that not only interrupt the flow of the *chronos*, but are at the same time existential transformations in a mythical space (in some cases – in a post-apocalyptic space) that is temporarily untied from historical time (*chronos*). In this sense, *Kairos* can also be a way of constructing the apocalyptic narrative, where the apocalyptic temporality of *Kairos* is connected with surviving existential transformations (revelation, rebirth, awakening) in a post-apocalyptic space which is interruption (rupture) and as the final end of a linear chain of events, temporal interruption of a chronological, historical narrative (Lindbladh, 2019). "The temporal structure of this apocalyptic narrative can be described in terms of *Kairos* rather than *chronos*, which means that the radical event is represented in relation to its impact on the characters in the present, contributing to their self-transformation, rather than as an end "set in the future, in a chronological view", thus revealing "the ultimate meaning of history" (Oppo 2013, 24 cited from Lindbladh, 2019, p. 14).

Interplay and tension between *chronos* and *kairos* are not only ontological qualities of time which were pointed out by Ancient Greeks. They are distinct and interweaving ways to structure the narration.

The Chernobyl Museum could be analysed in terms of interrelation of these different temporal modalities. Temporality construction reflects timeline as an organising structure of museum expositions to present and understand the past, when events are organised in the timeline, which is narrative by itself, a way to tell a story, which is recognised by a visitor even when it is being constructed – when separate stages and divisions of time are not marked (Lubar, 2013). A linear chronological structure of timeline, when events and exhibits are set out in the space according to a line of historical sequence, is the most traditional way to construct the timeline. The exhibits are linked to a physical space, when, physically moving, a visitor goes through a sequence of events of the past being constructed – materials of the exposition situated in the space following the logic based on the historical sequence, from earlier to subsequent times, from the past to the present; the visitor in the museum timeline walks through history (Lubar, 2013). The situation of the timeline as chronology reflects *chronos* temporality, when exhibits are set out in compliance with the logic of a historical timeline. However, contemporary museums, as Lubar (2013) has it, seek constructing even more complex flows, when, for


**Fig. 2:** Road signs depicting abandoned and uninhabited towns after the Chernobyl disaster

instance, part of an exposition is set out according to chronology, whereas other parts follow other principles. Specific strategies are used (for instance, hypertext) to create a more sophisticated and more open structure of the narrative, which is a "less coercive kind of chronology".

After entering the Chernobyl Museum, a visitor occurs in a lobby which, besides its functional purpose (ticket office, cloakroom), is also a specific exposition: the entire lobby and stairs leading to major exposition halls upstairs display road signs similar to those used along roads when leaving settlements (a name of a settlement is crossed over with a red line). Names depicted on these road signs are the names of actual villages and settlements in Ukraine (see Fig. 2).

The lobby of the Museum symbolically marks the consequences of Chernobyl, when thousands of hectares of land left abandoned, and many settlements remain neglected and unsuitable for living due to contamination with radiation. Additionally, there is a place in the lobby where temporal expositions are situated. At the time of our visit (January 2019), there was a mini exhibition (photographs) from Japan depicting the disaster of the Fukushima Nuclear Power Plant. When considering temporality of this part of the Museum, one may notice that the entire exposition of the Museum starts not from the moment of explosion of the nuclear power plant (April 1986), but, when entering the Museum and occurring in the lobby, we start moving in the physical space from exhibits which represent the Chernobyl disaster aftermath (abandoned villages) and neglected empty, contaminated territory of Ukraine. The exposition moves a visitor from Fukushima to the year 2011, which is 25 years past the Chernobyl accident; the connection between the largest disaster at the nuclear

power plant and another large accident in Fukushima is revealed. Thus, the beginning of the exposition is the post-disaster period.

The next point in the moving around the exposition as well as another experience of time deal with an exhibit of a clock showing the time of the accident: 1:23. The clock has stopped (broken). This is one of the most prominent symbols directly signifying the conceptualisation of time in the Museum. This clock marks the time of the accident, when a mechanical device no longer works due to mechanical damage – explosion of the reactor. The exposition starts with this metaphor of a stopped time demonstrating the disjuncture, rupture of a historical flow of time (*chronos*). The accident itself along with the stopped time and the broken clock are depicted as interruption and breaking of a historical timeline, a rupture, when history of the entire humankind like a ceaseless moving – a road towards technological progress and brighter future of the humanity stops (a metaphor of a stopped/broken clock), the historical timeline being created by humanity for years and meant to lead to that likely future which had to be better than the "present" is broken.

The stopped clock symbolises an interrupted and stopped flow of ordinary time and tame reality; the flow of the life which was lived by the state, humanity before the accident, and stopped time which will no longer exist – like interruption of the lives that proceeded earlier (see Figure 9). Along with it, the limit of the stopped time indicates the end of a specific historical time (*chronos*) – the time before the world changes – enters the irretrievable period of time, the period with no way back to the time where this apocalypse has not happened yet. The stopped clock is a particular metaphor of rupture of hegemonic temporality and unified global chronotic imaginary, dealt with by Hom (Hom, 2018). The ceased hegemonic temporality, in this case, the historical time of human evolution, is being constructed in a cultural, political and social way; the flow of time is depicted as an arrow-like line, where development of nuclear energy, along with development of entire science, was related to the technological progress. As Hom (2018) puts it, talking about hegemonic temporalities, rupture as temporal disjuncture is shocking and unprecedented moments of radical discontinuity; it "disrupts" hegemonic logics. A disruptive moment (i.e. an event) disrupts the "present" and "history" which were constructed as dominating/hegemonic temporality (in this case, it is constructed history of technological progress with the "bright" future of nuclear energy).

The explosion of the Chernobyl Nuclear Power Plant becomes this disruptive event in the hegemonic temporality (unified global chronotic imaginary). After entering Museum's hall 1, starting with the first exhibits, they describe what has happened in the nuclear plant and that the explosion happened. Since

the *chronos* time stopped (the stopped clock as a metaphor), the meaning of the *Kairos* time becomes highlighted. The accident itself is a karoitic event which stopped the flow of *chronos*. Moreover, the stopped/broken clock symbolises the end of time as such; this is the entering of the eternity where time is no longer counted (is eternal "now"). By stopping, the clock shows that not only ordinary, "happy" time of millions of people who took part in the liquidation and directly suffered from radiation has ended; the time stops for the entire relationship between humanity and nucleus, a naïve attitude towards the peaceful nucleus ends, before entering the new post-apocalyptic reality where lives proceed alongside the Chernobyl Zone, hundreds of people who fell ill from radiation, the territory contaminated for hundreds of years and a doubt that occurred forever about the safety and suitability of the "peaceful nucleus".

The first hall of the Museum displays activities of nuclear power plant's operators and engineers, whose performance led to the explosion, by presenting a text on the proceeding of causing the accident. Being aware of the whole flow of further events, we know that this moment was highly important; we know that these actions of operators and nuclear plant's engineers became decisive and life-changing moments, turning points in time (in this sense, it is the kairotic moment), which actually changed the entire *chronos* time, symbolised by the clock, and the flow of the historical time (reflected by a calendar).

On the one hand, no doubt, actions of dispatchers and managing bodies that led to the disaster are described in the text of the exposition, in such a way demonstrating what has become the beginning of the significant event at Chernobyl. On the other hand, we can observe that much lesser attention is paid to the description and presentation of this trigger event of the disaster, as a karoitic interruptive event, in comparison to other available cultural representations of the accident. To compare, let us remember the BBC documentary film "Chernobyl Nuclear – Surviving Disaster (BBC Drama Documentary)", where five minutes of the text at the beginning of an important film are allocated to the drama in the dispatcher office (when the actors playing major characters perform not only actions but also the drama of actions and feelings that took place). The drama in the dispatcher office that led to the accident, as a karotic interruptive event, is given much attention in another important text on Chernobyl making up intertextuality of the Museum – the HBO miniseries "Chernobyl" (2018). Here, even two episodes are dedicated to this event (everything what happened "before that symbolical clock had stopped"): the first episode shows "how this all started" and the last, fifth, episode, after presenting the drama of the liquidation of the disaster in earlier episodes, returning to the decisive moment that changed the history and stopped the time and clock,

back to depiction of the actions of the dispatcher team. Later in this episode, actions of the team that led to the disaster are commented while repeatedly showing the trial of the causers of the Chernobyl disaster, explaining through a scientist Legasov how the reactor operated and how the accident had happened when members of the dispatcher team specifically acted and made particular decisions. Comparing with mentioned other representations of the Chernobyl disaster (HBO miniseries "Chernobyl", BBC documentaries), the Museum pays quite little attention to the analysis of the actual event of the accident. As depicted in the exposition, the event of the accident itself that broke the historical timeline of events is presented quite in brief, by mentioning the participants, shortly identifying their actions. Slightly more attention in this exposition is paid to what has happened after the accident, by discussing how the investigation, trial proceeded (closed procedure of the court), what punishment was imposed on the managing bodies and remaining alive direct participants who were present at the dispatcher control desk; their health condition is discussed and causes of death (radiation sickness) are mentioned.

When discussing the presentation of the accident moment in the Museum and comparing it with other above-mentioned fiction and documentary texts, one can notice that the technical and human emotional dramatic moment/episode of living the very first minutes and hours of that historical and human experience in the dispatcher office is presented in brief (textual factual information), without engaging a visitor into emotional experience of the participants involved in those decisive minutes and hours of actions and feelings in the dispatcher office that changed the world. We suppose that representation and construction of temporality of this moment that happened in the dispatcher office can be differently constructed in a text. We see that even though this moment is represented in the Museum as karoitic (that disrupted the planned and anticipated flow of historical time), this karoitic moment is depicted as a disruptive moment which actually happened because the space for an agential possibility was opened (actions of the dispatcher team that led to the accident were that negative and ill-fated agency which aimed at performing extraordinary successful testing turned into a fatal error that changed the flow of history). The karotic moment as the capacity of individuals to act in a given context agency and having the transformative potential to subvert the *chronic* logics and continuity, in this particular case, opened the Pandora's Box and created a new trajectory and direction of the historical flow line. To present and reveal this decisive moment, the Museum allocates quite a small part of the exposition, and, to compare with other analysed documentaries and films, this moment is not emotionally, existentially and dramatically presented. This could be

linked to the very genre of museums, which has different possibilities to present dramas, other than those provided by cinematography and literature.. This karoitic moment becomes disruptive because it opens a new historical line – it breaks explanatory/interpretive frameworks (constructed successful history of the nucleus of the state and the humankind), and in this sense it no longer allows "anticipating" the future.

According to Hom (2018), rupture links closely to the "trauma time"; this fractured moment creates incapacity in acting and interpreting, since the fall of hegemonic temporality creates absence of interpretation. The future becomes radically open and this disruptive moment as a radical break, *rupture*, the event which disrupts the "present" and "linear time", *destabilising* hegemonic temporality (as a dominating politically and culturally constructed idealistic vision about the move of history and the humankind towards progress in line with the myth of safety of nuclear energy) and future as an alternative which is unknown and *"something completely different"*. The event 9/11, when planes piloted by terrorists smashed into the World Trade Centre and the Pentagon, opens the unknown and cannot be integrated into the existing dominating hegemonic historiography, and, thus, is an event of a similar kind. Back then it could not be placed in a larger historical context and narrative structure; they were disruptive singular events (Hom, 2018).

The drama in the dispatcher office at the Chernobyl Nuclear Power Plant as a rupture can be explained in a similar way. After the accident happened (as a result of what has happened in the dispatcher office), the unknown, new likely horrible trajectories of the history line-to-come open, which were beyond the people's ability to explain and consider; in this sense, the "trauma time" opens. It can be treated as a karoitic interruptive event; only in this case what is disrupted is the line being constructed in the future drawn by *chronos* as the homogeneous, orderly and seemingly objective flow of time; the future-to-come opens after the explosion of the reactor, which has no interpretative framework of how to explain. Later, this rupture causes a new flow of events – fire, penetration and spread of radiation; contamination of Ukraine, Belarus and large part of territories across Europe; harm to people, nature and ecosystems.

To prevent the opening of these new historical apocalyptic lines (of newly constructed *chronos*), a whole liquidation of the disaster as one grand event comprising smaller events was created. After the explosion, actions of the teams of liquidators directed to liquidate the accident are presented in the exposition as separate karoitic moments. A special attention in the exposition is focused on heroic liquidation of the consequences of the accident, the actual events that allowed creating measures to stop, reduce the consequences (extermination of

fire, construction of the sarcophagus, cleaning of the territory). Referring to Hom (2018) dealing with the perception of time during disruptive events, after the rupture happened (actions of the dispatcher team that caused the accident, the explosion) the agency of other people – liquidators – started operating. Another karoitic moment, which created the *rupture of rupture*, started. The campaign of liquidation of the consequences of the disaster is a heroic deed which allowed blocking, reducing the newly occurred trajectory of the flow of events, a new apocalyptic historical line. The liquidation is treated as actions of the *rupture of rupture*, as an attempt to terminate the termination, an attempt to control the times of rupture, "transforming it from a description of traumatic and unliveable conditions to the foundation of a novel ethics that insists we 'remain with uncertainty' and 'hope that something different' will emerge" (Hom, 2018, p. 327). These liquidation actions are treated as karoitic moments which become the disruptive event as a response to the new apocalyptic vision of the history with unclear and horrific future, which is created and drawn by the accident itself.

In the first part of exposition at the Chernobyl Museum (halls 1 and 2), a visitor gets acquainted with a presented proceeding of the liquidation campaign as one grand event which becomes that actual karotic interruption (*rupture of rupture*). This one grand event is divided, presented to a visitor as a sequence of smaller events. Separate teams of heroes – fire-fighters, helicopter pilots, miners, soldiers cleaning the reactor's roof from graphite, all other teams – physicians and other participants, are introduced. Each team is introduced separately; emphasising the character of their work; singling out family names of individual people, their actions; and highlighting the radiation doses they obtained. Almost in every case, the harm to health is mentioned, and further proceeding of actors' lives is noted – usually, the year of death or a degree of affected health is described. Thus, a visitor sees that a large army of liquidators is divided into smaller professional groups, in such a way rendering these groups some individuality, exceptionality. The whole group is characterised: its role and approximate number of the participants; also, the harm underwent by the entire group is underlined. Inside each group, single actors are chosen (their names, family names, further destinies are mentioned). Such division of the liquidation operation as the whole into smaller groups, singling out separate heroes-individuals in each group, is a way to show the entire historical event through a more individualised perspective, by revealing separate groups and single heroes, demonstrating heroism of these people. In this sense, the exposition attempts to point out the karoitic moments – a specific aspect of

time, when a grand historical event is presented through actions and lives of individual people.

Heroic actions of the liquidators can be viewed as the karoitic moments, when the *rupture of rupture*, the interruption/suspension of the flow/line of that apocalyptic history that could have had happened/occurred after the accident proceeds. This is the *rupture of rupture* moment, as a karoitic moment, when an opportunity for agency of people was opened up, when in the time of crisis a response was required and a decision to be made, an action to be taken (Winderman, 2017). These heroic actions became the decisive and life-changing moments; this was the "right time to act" with transformative potential to subvert the *chronic* logics and continuity, which, in this particular case, is set/drawn by the already happened accident and the *chronos* logic which had to lead to the apocalypse. On the one hand, an extraordinary contribution of all teams of people to the liquidation reflects the role of human agency in creating a new line of history (rupturing the rupture). This was achieved, thanks to heroism (presenting completed technical operations, showing technical challenges and difficulties) and self-sacrifice of these people. On the other hand, when comparing the narrative of the Chernobyl Museum with other fiction-documentary texts dedicated to Chernobyl (S. Alexievich's book "Chernobyl Prayer", HBO series "Chernobyl", BBC documentaries featuring actors), we can observe that fates of the people, their existential experiences, are demonstrated in the Museum in a rather narrow manner. In her book, S. Alexievich constructs the experienced liquidation of the disaster and the post-accident period through magnifying experiences and suffering of individual participants (liquidators, wives, scientists, physicians); separate experienced moments are singled out by phenomenologically profoundly magnifying/revealing them as if looking through a magnifying glass; the life events are described in detail by mentioning actions, feelings and philosophical pondering. We find quite many such moments in the HBO series "Chernobyl" as well; the series were created grounding not only on documentary materials of archives, but also Alexievich's book – when people's experienced moments, many artistic symbols and metaphors, and tragic and dramatic suffering of the heroes resulted in high emotional response of audience, readers.

Whereas despite the above-mentioned single moments introducing individual personalities and names of people, mentioning their life facts (disease, death), the Chernobyl Museum does this without revealing description of one person's life moment in full, as it is done in other already discussed pieces. Such non-disclosing of people's existential experience indicates the domination of *chronos* temporality in this part of the exposition (halls 1 and 2). The explosion,

accident and liquidation of the consequences are being constructed as an event situation in time, having its specific linear chronology and timeline, when the historical event, i.e., the explosion of the nuclear plant and liquidation/reduction of its consequences are presented as a sequence of actions and events situated in the timeline – from the explosion and liquidation of the consequences, having the sarcophagus over the reactor and cleared up Chernobyl Zone as an outcome. A visitor creates this logic of chronological order and line while physically moving from introduction of one team of liquidators-heroes to another in the exposition. While presenting the consequences of the explosion of the nuclear power plant and demonstrating actions of the nuclear power plant's personnel (engineers, shift of dispatchers, managers) (halls 1 and 2), the time represented in the narration is being slowly "counted" and introduced minute by minute (here, the karoitic element is quite strong); whereas while presenting actions of fire-fighters who are extinguishing the fire the time is counted by hours.

Later, the narration "moves faster", and the chronology is measured by days – joining in of other groups of rescuers and their actions are already being counted by days (miners, helicopter pilots, soldiers cleaning the reactor's roof from graphite); further, the time is counted by months and years (clean-up workers – soldiers, military officers). At the end of the second hall (physically moving around the hall and travelling "in time"), a visitor finds introduction of the role of physicians and scientists, which also points out not only the role of medical staff at the start of the liquidation, but also the role of physicians and scientists when treating the victims several decades later, investigating the long-term effect on people's health and biological environment. In such a way, a new historical line and the chronological ordering of the time flow/structure (*chronos* time) are created. The events attributed to the time of the several first days (first 3–4 days), i.e., actions of the governing bodies of the Soviet Union being reticent in public (in major dailies, like "Pravda") about the accident; dedicating a very brief press release; a small patch of text on a large sheet of the newspaper and the non-cancelled, arranged in Kyiv; festive demonstration dedicated to celebration of the 1st of May, "as usual"; and aiming to prevent from panic and pretend that nothing extraordinary has happened.

Later on, the timeline of the presented events is counted by weeks and several long first months aftermath: when during the first month all brigades of liquidators (helicopter pilots exterminating the fire, miners digging the tunnel) join in, the exposition of the timeline of several first months introduces soldiers on the military duty equipped with shovels throwing pieces of graphite down from the reactor's roof. From a very accurate counting of time by seconds there

is transition to the representation of the time flow by days, months and years. In the first part of the Museum intended to reveal the role of the liquidators (halls 1 and 2), a visitor gets acquainted with the period, starting with the explosion, liquidation works taking place (extinguishing the fire, removing radioactive graphite from the roof (how many months) and covering the reactor/constructing the sarcophagus over the nuclear power plant (how many months/years), cleaning, "deactivating the territory" and creating what presently is known as the Chernobyl Exclusion Zone (as an isolated territory which is currently uninhabited, but the works of de-activation/liquidation proceeded there). Besides already mentioned participants, i.e., nuclear power plant's personnel, fire-fighters, helicopter pilots, miners, soldiers and military officers, at the end of the first part of the exposition, the role of medical staff, scientists of nuclear physics and medicine is presented. Even though the major intention of the first part of the exposition's narrative is to show the role of various groups of liquidators and in such a way to commemorate their role and pay tribute to them, we can also recognise the chronological narrative along with the major narration, when the entire mission of clean-up workers and liquidators is set up as a chain of separate events with logic of its flow.

Thus, the timeline as a way to structure a narration is quite complex, sophisticated in the Museum, when, besides traditional chronological representation of the proceeding of events inserting them into the historical timeline (*chronos* temporality), there are attempts to present another modality of time – *kairos*, showing interruptive moments of the flow of history, revealing people's agency potential, attracting attention to single details, and experiences of individuals' lives. In comparison to other earlier mentioned fiction texts on Chernobyl (the book and series), these elements, however, have quite limited *kairos* as existential experience of people and emphasise the *chronos* modality of time more strongly in the first part of the exposition (halls 1 and 2) dedicated to underline the role of liquidators as heroic deeds. The Chernobyl Museum becomes a memorial commemorating the historical event which happened at a particular historical point, having perhaps changed the history of the humankind forever.

The Museum's expositions narrate a story which disrupted that other imaginary and anticipated history and other chronology (that possible alternative history of the Soviet Union, Ukraine and humankind) which could have happened/formed if the accident had not happened. Authors analysing the timeline in exhibitions (Lubar, 2013), dealing with the chronological ordering of time of traditional expositions underline that timelines highlight before and after, cause and effect, and linear progression (Lubar, 2013). When exploring the chronological logic of the narrative of the "event" and phenomenon of the

explosion of the nuclear plant and liquidation, this logic "before and after" (one action follows the other, there is proceeding of liquidation as a sequence, cause and consequence of events; liquidation works and heroism of liquidators as a cause of the sarcophagus covering the reactor and rescuing the humankind from doom) is revealed; and there is the Chernobyl Exclusion Zone itself as a "cleared up" (partly de-activated, washed out) territory where radiation has been localised and is not spreading out. The idea of progress and advancement that is implicitly characteristic to chronological depiction of the time flow is presented in the exposition of the Chernobyl Museum in quite a complex way. As investigators of the timeline in expositions emphasise (Lubar, 2013), the chronological timeline is characteristic of presentation of history as a line that leads to progress. On the one hand, the accident itself and its consequences (contaminated Ukrainian territory for hundreds and millions of years, damage done to health of inhabitants and liquidators) are depicted in the exposition as impossibility of the lines of history being constructed by the humankind, the lines that led to progress before the accident – this "pre-accident" line of the historical flow was disrupted by the accident. The stopped clock symbolises impossibility of the progress imagined in the past (before the accident) and planned, approaching "better future" (it is impossible to return to the pre-accident situation).

On the other hand, the extinguishing of the fire, construction of the sarcophagus and partial de-activation of the territories, and safeguarding of other territories (those of Europe and entire humankind) from even larger catastrophe are considered to be a specific progress (improvement) in the chronological presentation of the liquidation of the accident. This is the "small" progress which we recognise in a general Chernobyl-related idea of the history of the eschatological "fall" and regression.

Analysing timeline in museum expositions, Lubar (2013) discloses the strategies applied by contemporary museums allowing creation of a more sophisticated and more open structure of the narrative, which is a "less coercive kind of chronology". In the case of the Chernobyl Museum, this more sophisticated strategy is implemented through the merging of two lines depicting history, when the disruption of the historical line of the happened accident is combined with regress of the historical process, also including depiction of "afflatus" – depiction of reduction of the consequences of the accident as logic of chronology and hidden afflatus/progress. Reduction of the consequences of the accident, as a sequence of events having their own chronology and achieved result (sarcophagus, localisation of radiation within the Zone), is directly related to another important narrative of the exposition – the narrative on liquidators as heroes.

Exactly these endeavours and actions of the liquidators organised in a chronological order have created a new quality and new reality after the accident: the fire was extinguished, the sarcophagus was constructed, and the territory was cleaned up. Sophistication of the narrative in this first part of the exposition dedicated to the liquidators is implemented in compliance with a very specific strategy: information on the future of single individuals and separate groups is presented when chronologically organising the proceeding of the happened accident and liquidation of its consequences, presenting the works and introducing single people and separate groups of liquidators (nuclear power plant's personnel, fire-fighters, pilots, miners, soldiers, medical staff, etc.) who actually started acting from the very first hours, months and throughout the entire period of liquidation; the narration is on when and how these people died (separately presented are the cases of deaths immediately after the accident (firefighters), in other cases the same fate happened several months, years or decades later (after they got ill and died from the radiation)). Thus, there are two principles of classifying and organising exhibits – the liquidation works (this is reflected by presented groups of liquidators by professions – fire-fighters, helicopter pilots, miners, soldiers, etc.) and the chronological principle, when these works are organised across time.

Thus, from the point of view of construction of the proceeding of the events, this is quite a complex way to show the "historical" event that has been lasting for 30 years – while depicting it in full precision, arranging events and people in a chronological sequence by minutes-hours-weeks-months-years. On the other hand, in this clear line of chronology of events, "ruptures" occur – these are excurses to the future of the liquidators (different circumstances and dates of diseases and deaths). Even though it is possible to recognise the chronology of arranging exhibits (characteristic to traditional museums) in the Chernobyl Museum, still the road from the past to the present which is constructed by a chronological linear narration is being constructed in a sophisticated manner.

## *Kairos* in the Symbolic, Philosophical and Religious Narrative on the Disaster

A special construction of the narrative and temporality is discovered in the third hall of the Chernobyl Museum. The exposition of this hall demonstrates the attempt to move away from the heroic narrative and chronological temporality towards depiction of existential suffering and emphasising the *kairos* temporality. The construction of time becomes more sophisticated than the

chronological organisation of time (*chronos*) and a multiple hetero-temporality occurs, which allows problematising clocks, calendars and heroic state narratives.

Here, another strategy and logic of organisation of the exposition are followed: the effect of the accident on residents, children and women, and victims of Chernobyl in the Chernobyl Zone villages are depicted. Exactly this hall is an attempt to create a narrative as a more complex, sophisticated organisation than chronological. Authors, analysing the timeline in museum exhibitions (Lubar, 2013) have it that in contemporary museums there is an attempt to de-emphasise chronology and time as the organising structure of the exhibits and to use common human experiences as the thematic framework – to approach history from the standpoint of common human experiences of family, work, community and sense of place. The third hall reflects the aspect mentioned in the disaster studies – cultural representation of a disaster aims at depicting how communities after disasters live; how disaster-stricken nuclear communities have tried to cope with disaster by creating meaning, by maintaining resilience; going through processes of reconstruction, regeneration and recuperation; and creating new values and norms. Researchers dealing with disaster studies (Webb, 2018) reveal that a disaster-stricken community creates values and meanings reflecting revival, recovery and the signs of hope. In the Chernobyl Museum's hall 3, we find symbolical philosophical and religious meanings of the nuclear disaster.

If the first part of the exposition (halls 1 and 2) is dedicated to the liquidators-heroes and a clear chronological logic of narration is recognised, in the case of the third hall, a visitor finds an artistic exposition including many symbols dedicated to commemoration of citizens-victims, emphasising extraordinary suffering of village inhabitants and children. This part is not chronologically organised. On the one hand, in the aspect of time, all human experiences undergone by people throughout thirty years after the explosion (without singling out detailed and precise chronology) would belong here. On the other hand, exhibits and installations presented in all this appeal to the sense of non-temporality and eternal time – here, religious, existential lived experiences, and eternity and infinity of time are appealed to. In the hall 3, a visitor discovers a place of experiencing existential, sacral disaster. Here, one should remember symbolic forms of representations of disaster – theological and mythological motif of theodicy and divine involvement, as pointed out by Holm (2012). The halls 1 and 2 narrating about heroism of the liquidators reveal more social and political aspects of the disaster, whereas in the third hall the disaster is constructed as a religious, existential and philosophical phenomenon.

This part of the exposition deals with cultural construction and representation of the Chernobyl disaster presenting physical, psychological and spiritual suffering of Chernobyl sufferers – resettled persons and inhabitants of contaminated territories. In this case, the collective identity is being constructed not through heroism but rather through belonging, commonness in suffering and belief. Here, experiences lived by the community several decades after the Chernobyl disaster are presented. This hall has specific iconography. The first and second halls are characteristic of a documentary genre: the event of the accident is chronologically described in detail; particular people having their family names are introduced; and historical artefacts and documents are displayed. Black and white colours prevail in the first two halls, corresponding to the visual style of exhibited documents (black-and-white photographs and documentary films, blackish grey colour of the burning reactor, dark colours of uniforms worn by statutory officers and those of technical mechanisms; all materials (photographs, texts) are organised in a line on walls at the visitor's eye level, without more complex, sophisticated spatial and colour solutions); whereas the third hall presents an artistic project including many artistic-religious symbols, without displaying any historical documents and historical materials. The visual style is characteristic of colours, illumination effects and complex arrangement of exhibits in space (on walls, floor, ceiling). The purpose of this artistic installation is to create emotions, to represent suffering of people (residents and community). Artistic installations of this hall encompass many mythological and religious symbols. These mythological-religious symbols are used together with already traditional iconographic images of nuclear energy and nuclear disaster. One of such images widely used in various photographs, films is the image of a liquidator wearing a special protective green uniform and a gas-mask – a de-personified man without face and eyes, an unrecognisably veiled persona (who may even be not a man in this iconography at all, but an animate robot-function of the post-disaster techno society). In this hall, liquidators are depicted next to religious and spiritual symbols (large crosses, icons) (see Fig. 3).

Exploring this hall, we find strategies and techniques of representation which are described in museums aiming to render the suffering of victims and also seeking avoidance of direct frightening depiction of atrocity. These aesthetics techniques are applied in Jewish museums which commemorate the Holocaust; unique aesthetic and spatial strategies draw on particular aesthetic techniques of representation to evoke specific experience and sensations of the sacred by demanding a "particular form of contemplation" (Hansen-Glucklich, 2016). It is choreographed within museums and their exhibits through a number of

**Fig. 3:** Images of a liquidator wearing a special protective green uniform and a gas-mask next to religious and spiritual symbols

techniques, including spatial design, the use of symbolic materials and forms (such as water, rock and light), and the manipulation of the visitor's movement through space and passage.

A golden gate with two sides to enter – white from one side and black from another, situated at the entrance to the third hall – symbolise the gate between heaven and earth. The floor at the entrance to the hall is a chessboard, with white and black colours symbolising a game between life and death, balancing between black and white, good and evil, and life and death.

Another exhibit having a religious-spiritual function in pondering on the suffering of victims after the Chernobyl catastrophe is a candle flame demonstrated on the monitor's screen. A visitor has an opportunity to approach the monitor and light a candle, watch the flame wavering on the screen. The symbol of a candle has many meanings; however, in this context, a visitor, having lit a candle and immersed in the contemplation state, can see this flame of a candle

as a sacred fire, the light of God, the light that illuminates the path for the dead in their journey; it can be seen as a sign of illumination and hope.

A special place of this exposition is allocated to the suffering of children. One of the most memorable exhibits of the hall is a large photographic/arts installation depicting the Fuel Assemblies of Nuclear Reactor from RBMK reactor's Central Hall: photographs of children are placed in all separate elements of the Fuel Assemblies. These children were born in 1987–1988 into families of people evacuated after the Chernobyl disaster and people who were working on the sites of the catastrophe. This exhibit has a purpose to emphasise that the nuclear disaster had effect on children's health, fates, and took away thousands of children's lives.

In the middle of the third exposition hall, there is a boat with toys and plush animals. Two angels – white and black, hang above the boat; these are symbols of life and death. The boat is a religious symbol mentioned in Christianity and other religions; on the one hand, it depicts a journey and a voyage of life, when the boat carries people through life's shifting currents; on the other hand, it is a symbol of safety, security and refuge, when God protects believers. In the context of the Chernobyl catastrophe, the boat with the angels of life and death can be treated as a religious symbol telling that souls of ill or dead Chernobyl victims' children are fostered and safeguarded by God. Separate exhibits of this hall highlight the effect of the Chernobyl disaster on the entire humankind. The catastrophe altered the fate of the whole world's nuclear energy for ever – this disaster shook the understanding of the nuclear energy as reliable and secure throughout the world.

In this hall, next to the exhibits of the boat, burning candle, gates of life and death, visitors find/see a map of the world created as an installation of lamp bulbs. Looking at the ceiling, one can see lights which represent nuclear power plants operating in Europe; having turned his/her head, one sees South and North Americas, Asia, Australia and Africa in the centre. The map is supplemented with the data from the International Atomic Energy Organization (2012): in 2012, 34 countries of the world had 435 operating nuclear reactors. Almost half of them were built in 1970–1980; two of them have had irreversible consequences for society, i.e., Chernobyl disaster in the 20th century and Fukushima explosion in the 21st century. This artistic-visual depiction of global energy as a geographically situated industry, including all religious-philosophical symbols in this hall, creates a narrative which expresses some doubt about further development of nuclear energy. The subjugated and employed to human needs nuclear energy brings together largest disasters and suffering. In such a way, here a narrative of development of science, economy

and industry is criticised and questioned while juxtaposing to philosophical and religious-spiritual consideration of the suffering from the nuclear disaster.

## Conclusions

Analysing the educational potential of the Chernobyl Museum, we attempted to view the exposition from the perspective of disaster studies. In its specific manner, the Chernobyl Museum constructs, frames and interprets the Chernobyl disaster; it is a manifestation of collective imagination and memory work. Aiming to fully reveal and use the educational opportunities of the exposition, it is possible to construct in the education process (school curriculum and non-formal learning) a stronger educational effect through intertextuality – by employing additional texts (using fiction, documentary and feature films). As demonstrated earlier, the Museum's exposition can be "read" and used as an educational text/teaching aid in interaction with other known texts on the topic, e.g., S. Alexievich's book, HBO series, BBC documentaries on Chernobyl and other creative artistic projects. On the one hand, juxtaposition of these texts allows better understanding of the specificity and uniqueness of cultural, political and social interpretation presented by the Museum; on the other hand, having combined the Museum's exposition and other texts, a multiple image of the catastrophe makes up.

Considering that the Chernobyl Museum is a national museum, it would be beneficial to analyse in the education process how exposition of this Museum is the manifestation of the institutional memory policy. Such explanation would be a particular attempt to deconstruct the narrative, to recognise not only the content of the narrative but also to reveal what institutions and how create it. No doubt, when creating the Museum's exposition, there was collaboration with the liquidators and various organisations; thus, the exposition itself is a result of happened "negotiations" among different groups (national memory policy, liquidators and their relatives, organisations, various supporters). It would be interesting to analyse different cultural representations of the Chernobyl disaster (Alexievich's book, HBO series "Chernobyl") and compare them as stances on explanation of the past carried out by different organisations and groups during history, social sciences and geography classes for senior form students. Here, it is worth noting that criticism towards Alexievich concerning books on Afghanistan and Chernobyl is expressed in public. These critics say that she presents a point of view which strongly differs from the official, institutional interpretation of the mentioned events emphasising heroisation, necessity and meaningfulness of self-sacrifice. The HBO series "Chernobyl" is

also treated as a specific version and interpretation of the events by American creators much grounding on the said Alexievich's book, various documentary sources. Thus, an additional educational effect is created by an opportunity to compare the content of different narratives on Chernobyl, their relation to official institutions of the memory policy and various groups of interests in the education process.

Besides critical deconstructing attitude towards the content of the Chernobyl Museum's exposition, for educational purposes, it would be meaningful to analyse together with students the structural approach towards disasters which reveals how organisations and communities mobilised response efforts. Alongside with other mentioned texts, the Museum presents an image of how the Soviet Union structures operated in a "*state of emergency*" and how the Soviet emergency crisis system functioned. The version of how to cope with the disaster consequences presented by the Museum may be integrated into the school curriculum through the content of taught subjects – history, public sciences and geography. Besides the understanding of how the emergency system functioned (including heroic deeds of citizens, clean-up workers), the Museum's exposition combined with other sources (HBO film and BBC documentaries, Alexievich's book, etc.) may render knowledge and understanding of how the science of nuclear physics operated as a social institute under the conditions of constraint and secrecy in the Soviet regime, how it impacted the development of the nuclear energy, and, finally, how the Chernobyl disaster induced the collapse of the Soviet Union and made an effect on the fate and future of nuclear energy worldwide.

Environmental and nuclear geography is another important topic of the educational impact. This is the content related to the learning about radiation, the contaminated nuclear landscape and nuclear communities. The Museum reveals the impact of ionising radiation and nuclear contamination on people's bodies and lifestyles, animate nature and landscape. The Museum's exposition presents geography of nuclearity which covers topics of how radiation has affected the territory and communities. It is important to underline that such learning about contamination does not limit itself with knowledge coming solely from biology, nuclear and radiation physics, chemistry, medicine and physical geography. The Museum develops the topic of nuclear communities and presents how the disaster affected communities of inhabitants not only physically, but also what that disaster meant to these communities in a social sense, how that disaster altered their social, emotional and spiritual world. The exposition illuminates how communities tried to cope with a disruption of

social meanings during the disaster, how it went through processes of social reconstruction, regeneration and recuperation.

The explanation about the interaction between Chronos and Kairos displayed earlier in the text demonstrates how through *kairos* temporality there is an attempt to show, create the existential-philosophical-religious sense of time and reality, how there is an attempt to perform the sense-making of existential suffering. This aspect of the exposition allows combining the attendance of the Museum as non-formal education with the school curriculum while integrating studies of literature, ethics, art, philosophy and religious aspects. Again, in this case, it would be meaningful to relate the attendance of the exposition as part of the education process to the analysis and experiencing of other fiction texts (literary works, films, art projects and exhibitions).

Analysing the Chernobyl Museum as a dark tourism site according to the dark tourism spectrum (darkest to lightest) presented by Stone (2006), we would attribute the Chernobyl Museum to the category "dark". In this case, the very exposition of the Museum is not directly a place of suffering or death (it is not the actual Chernobyl Exclusion Zone); it tends to create association with death and suffering. The exposition implements the feature of dark tourism – it renders a strong educational and commemorative orientation, and there is no emphasis on entertainment. One of the strongest narratives of the Museum – heroisation and commemoration of heroic deeds of liquidators, mitigates the "darkness" of the event, highlighting meaningfulness of heroes' self-sacrifice. Artistic installations in the third hall dedicated to the religious and philosophical contemplation on the disaster aim at transforming the experiences of death and suffering characteristic to dark tourism towards a moving aesthetical, existential and spiritual experience. Having used a broad arsenal of additional texts, spectrum of additional educational activities (likely being assisted by a teacher), Museum visitors have an opportunity to create a unique existential experience of learning.

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# 4

Lina Kaminskienė

# What We Find Outdoors: Discovering Nuclear Tourism Through Educational Pathways

**Abstract:** Outdoor education can take place in a variety of contexts, and its realisation in specific spaces can contribute to the development of educational tourism in regions that have not traditionally been classified as tourist attractions. The study revealed that leveraging outdoor education with formal and non-formal education programmes not only promotes the tourist attraction of the visited sites and places, but also creates new jobs and boosts development of museums and other cultural institutions. The decommissioning processes of the Ignalina Nuclear Power Plant have a direct impact on the social, economic, and cultural development of the Ignalina region and the city of Visaginas; therefore, the development of educational tourism has high potential here. Contextual and region-focused specific curriculum can stimulate the development of nuclear tourism in the region, taking into account the geographical location of Visaginas and the specific environment formed by the Ignalina Nuclear Power Plant. Utilising educational potential of nuclear tourism has great potential to attract learners from all over Lithuania and the neighbouring countries, mainly Latvia, Belarus and Poland. Outdoor education has a variety of ways to be implemented by utilising different pedagogical scenarios such as landscape analysis, school journeys, action research, outdoor adventure activities, cultural journalism or field studies. Outdoor education also contributes to the development of new forms of educational structures such as outdoor schools and kindergartens, forestry schools, STEM centres and others.

**Keywords:** outdoor education, place-based education, learning environments, educational tourism

## Introduction

In this chapter, learning environment outside the school and the classroom will be analysed and linked to educational tourism and place-based education. This discussion will help to review the educational potential of areas around Visaginas city and Ignalina Nuclear Power Plant. The educational pathways of the area are currently underexplored by educational researchers and school practitioners. This chapter strives to uncover diverse educational approaches relevant to place-based education directly and indirectly enhances the development of educational tourism.

Researchers still argue whether outdoor education is a synonym to place-based education, or they are completely separate concepts. The majority of authors agree that the idea behind different names is the same, but they are just labelled differently (e.g., Knapp, 2014), and only few consider that place-based education resulted in a historical development after such movements as nature study, outdoor education and environmental education. Sarivaara and Uusiautti (2018) argue that place-based education is closely related with outdoor and environmental education. They refer to Sobel (2004) who notes that place-based education connects the classroom and the community. Place-based education is also characterised as the pedagogy of place, which incorporates concepts of experiential education, community-based education, education for sustainability and environmental education (Sobel, 2004).

Outdoor education became particularly actualised after the publication of Louv's book *Last Child in the Woods: Saving our children from nature-deficit disorder* in 2005. Louv coined the term "nature-deficit disorder" with the aim to raise awareness that the contemporary generation of children spend less and less time outdoors and this situation contradicts to the foundational principle of being human. Louv (2008) noted that staying long time indoors causes harm and negative impact on physical and psychological health, and stressed the need for restorative environments.

Historically, the idea of outdoor education is not new, dating back to the 19th-century education; however, today outdoor education has developed new characteristics, and the idea of "outdoor" might be linked to real, virtual and imaginative places. Outdoor education can be defined as pedagogical activities taking place outside the classroom or the school surroundings. Other related and synonymous terms are: learning outside the classroom, *udeskole,* outdoor adventure education, heritage education, environmental education, field studies, etc. Researcher Fägerstam (2013) notes that two traditions could be identified regarding the outdoor education: the Anglo-Saxon and the Scandinavian tradition. The former relates outdoor education with adventurous experiences that focus on team-building and the development of leadership skills (Thorburn & Allison, 2010). It is also important to note that in the Anglo-Saxon tradition outdoor education is usually, yet, not always, associated with education that takes place in special educational centres, museums, science parks, etc.

The Scandinavian tradition of outdoor education is closely linked to formal education and is implemented as part of the formal curriculum. Fägerstam (2013, p. 1) claims that in the Scandinavian tradition "the term outdoor education most often involves school-based learning outside of the classroom, in the nearby natural or cultural landscape or on school grounds, often with

a cross-curricular approach". The researcher mainly refers to the works of Jordet (2007, 2010), who studied outdoor education processes in the regular Norwegian primary schools. It is worth mentioning that outdoor education in Norway has a special name "uteskole", which means outdoor school. The research performed by Jordet (2010) allowed him to develop a model of school-based outdoor learning. The key aspects of the model are that school surroundings are used as a learning arena and as a source of knowledge.

Rickinson et al. (2004) distinguish three types of outdoor activities: fieldwork and outdoor visits, outdoor adventure education, and school grounds and community-based projects. Fieldwork and outdoor visits are close to what Scandinavian researchers call school-based outdoor learning in the sense that fieldwork is usually linked to a specific curriculum (it may be geography, history, math, literature, etc.); however, it usually takes place outside the school settings and involves visits and field studies in the nature centres, parks, etc. Outdoor adventure education focuses on adventurous activities taking place most often in natural environments and involves such activities as mountain climbing, canoeing, etc. The third group of outdoor education activities is linked to school grounds and community projects that take place in nearby places, not very distant from the school.

The theoretical foundations of outdoor education are closely related to what Gruenewald (2003) defined as place-based education with the following theories of experiential learning, ecofeminism, problem-based learning, sociocultural theories of learning, Bruner's free discovery learning theory, and others. Gruenewald (2003, p. 620) claims that a number of contemporary educational strategies rely on the concept of the place: "Experiential learning, context-based learning, problem-posing education, outdoor education, environmental/ecological education, bioregional education, natural history, critical pedagogy, service learning, community-based education, Native American education—all of these approaches to education tend to include engagement with local settings."

Researchers Siskar and Theobald (2008) claim that not only the place, but also the community are the dominant concepts and approaches in contemporary education. Even though the community and the place are not identical concepts, it is most important that community cannot exist without a place. Siskar and Theobald (2008, p. 70) discuss the distinctions of the two concepts, but they both "represent a legitimate path to a much more substantive definition of what constitutes an education—or an educated person". Even though the idea of learning outdoors is not new at all, however, numerous discussions on how school curriculum could be linked and realised in various settings are

still continuing. There are open questions whether outdoor learning is limited to any geographical area, whether it is a part of formal curriculum or is mainly implemented as non-formal curriculum. Moreover, is it a mono-sectorial (purely educational) or multi-sectorial issue, when discussing about educational tourism? Whether outdoor education is somehow influenced by the tendencies developed by educational centres, museums, other places of touristic attraction, or is it a vice versa process that tourism industry discovered underexplored potential of education relating it to tourism development?

Following this discussion, it would be good to return to Gruenewald's (2003) observations that a multidisciplinary analysis of the place reveals high pedagogical potential as the place may unlock a variety of historical, cultural, biological and other diversities. Linking or even accepting outdoor education as a part of formal education allows the schools to become an equal player of the local context as well as to contextualise learning in real surroundings as opposing to simulative environments developed in the class. Gruenewald's (2003) work still remains highly actualised nowadays in many countries, going through national curriculum reforms, such as the Baltic sea region countries (Lithuania, Latvia), Eastern and Central Europe (Ukraine) and Asia (Kazakhstan, Georgia, Armenia), some years earlier in Scotland (Thorburn & Allison, 2010) and Finland (the New National Core Curriculum for Basic Education, 2016). For example, Salminen et al. (2016) observe that in Finland in 2010, the statistical data showed that schoolchildren aged 10–14 (grades 4–8) were the most frequent visitors in museums and other type of exhibitions. Researchers indicate that usually school groups are focused on learning subjects from humanities, arts and natural sciences. It is very important that some significant changes might be achieved by applying changes in the national curriculum, what, for example, happened with history studies. Similarly like in Lithuania, school children start learning history as a separate subject from the 5th grade, and accordingly, national museums receive much higher numbers of visitors from this age cohort. After the changes in the national curriculum from 2016, it was decided to start history studies at an earlier age, which museums and other public institutions had to accept and adapt to the new situation.

The dimensions of place-based education, including the perceptual, sociological, ideological, political and ecological aspects, are worth deeper consideration for the countries while reviewing their school curriculum. The idea of extending the notion of pedagogy and accountability towards the place is going as a red line in Gruenewald's work, and particularly today it is obvious that modern pedagogy needs new inspirations and stimulus to respond to a very demanding new generation, preventing them from being educated in an

isolated school environment. Moreover, as Cuthbertson et al. (2004) note, there are concerns that technologies put additional barriers between humans and the natural environment, which also raises new questions how technologies could be successfully exploited to bring students and environments closer.

The findings of scientific literature on outdoor education brings forth a critical analysis of current pedagogies and approaches to implement outdoor education and raises discussion on its interrelation with educational tourism. This chapter illuminates dimensions of place-based education and outdoor education and situates them in the array of contemporary educational theories and methods.

## Pedagogical Approaches in Implementing Outdoor Education

Naturally, all these conceptual discussions lead to questions how outdoor education can be successfully implemented in educational institutions. The analysis of scientific literature reveals a variety of approaches and cases.

### Pedagogies of place: natural history

Natural history as an educational tradition dates back to the Victorian and Edwardian England. In the USA, one of the most famous publications for teachers appeared in 1911, when Anna Botsford Comstock published the book *Handbook of Nature Study*. Natural history, as Gruenewald (2003) notes, allowed to keep close school-nature (place) connection while implementing the curriculum. Surprisingly, now in the 21st century, this connection in real implementation of the school curriculum for many teachers looks a complicated issue. Natural history is focused on deeper investigation of nature, landscape, biological and cultural diversity. It is not limited to rural areas but can be successfully implemented as pedagogical excursions in urban areas.

A team of UK researchers (Rickinson et al., 2004) analysed studies on outdoor education carried out in the period of 1993–2003. They also noted that historical development of outdoor education was well established in the early 20th century schools. One of the botanical educators was Dr Lilian Clarke who taught from 1896 to 1926, developed innovative teaching practices in the design and use of school gardens. The main principles behind the contemporary outdoor education were laid down in these "school gardens", and this type of education was aimed at promulgating the use of the "outdoor classroom"; stimulating a proactive view of learners' creating their own textbooks from "hands-on" work in the garden; recognising that teachers and learners contribute to the pace of

the lesson; and documenting the teaching to share with others (Rickinson et al., 2004). The contemporary educational traditions associated with natural history are field studies, outdoor adventure activities and landscape analysis.

## Landscape analysis

The landscape analysis method was developed as an educational method by the Place-based Landscape Analysis and Community Education (PLACE) programme, an innovative programme by the University of Vermont and Shelburne Farms. The main idea behind this method is to explore the region through the analysis of physical landscape, cultural landscape and ecological landscape. The method allows students to immerse in local heritage, cultures, landscapes, opportunities and experiences, using these as a foundation for the study of language arts, mathematics, social studies, science and other subjects across the curriculum. Landscape analysis is one of the approaches to implement place-based education; moreover, it also helps to develop learning through participation in service projects for the local schools and communities. The landscape analysis starts from physical analysis of the landscape, which involves not only geographical or topographical analysis of the landscape, but also urban structures, human and non-human characters. The physical, cultural and ecological aspects of the land are strongly linked and intertwined. Physical landscape analysis helps to understand the origins of flora and fauna of the region, distribution of population in the landscape. For example, Ignalina Nuclear Power Plant region in Lithuania is characterised by a big number of lakes, forests and a relatively small number of population in the area. The cultural landscape of the region always has manifold meanings, cultural artefacts and texts that need to be analysed. The cultural landscape analysis is not limited to centric objects (for example, Power Plant); it requires developing skills for identifying and analysing non-centric objects in the area and learning to unlock and understand their meaning (different living and industrial houses, new and neglected, small farms, etc.). Cultural landscape analysis focuses on a variety of objects and stimulates investigating causes why they have been constructed and what was their main purpose.

The third phase is related to ecological analysis. Ecological analysis is mainly focused to investigate interrelation of human activity with non-human structures, and thus, it strives to analyse how human beings affected and changed the regional landscape over time. Ecological analysis has many connections with environmental and sustainable education as it raises awareness about the interconnections in the regional ecosystems.

The advantage of the landscape analysis is that one may not implement it in sequential steps, however, going through all phases (performing physical, cultural and ecological landscape analysis) would definitely contribute to a whole understanding of the region by unlocking diverse natural and human activity treasures.

## School journeys (excursions)

At the end of the 19th century, the so-called school excursions or school journals became popular, and the person who contributed to the spread of this concept was Catherine Dodd. She supported the idea that educators should enlarge the environment that children could experience. Dodd brought children to various excursions into rural Derbyshire. The new education approach inspired many teachers, and up to now, school journeys have been among the most common outdoor education methods. The main challenge remains that still a lot of teachers limit outdoor education to school journeys and do not sufficiently link this activity with the formal curriculum. In this way, school journeys become simply adventure activities or activities just for amusement and fun without a clear conceptual line and intentions to develop specific abilities and competences. Education scholars and practitioners (Jovaiša, 1993, Garalis, Švagždienė, Liesionienė, 2008) note that school excursions, also called educational journeys, can be of different types. Depending on the purpose, they could be classified into educational journeys with the aim to introduce to the new subjects in the curriculum; consolidating the covered topics, providing overview and complex. The researchers also clearly identify strong connections between school journeys and tourism; however, they stress that teachers and learners should invest sufficient time to prepare for a journey. The preparatory activities usually involve reading and analysing the object(s) to be visited, as well as preparation of special instruments or tools used during the journey (for example, questions to be answered and templates for data recording). School journeys can significantly contribute to strengthening learners' motivation and help to achieve the planned learning aims. During the last decades, educational programmes have been developed in museums, theatres, information centres, etc., in order to address diverse needs of learners of different age groups. School journeys have a number of characteristics that are common to field studies.

## Field studies

Field studies in the UK started rising from 1943, with the establishment of the Council for the Promotion of Field Studies, and since then a network of

**Fig. 1:** Learning in a simulative pilot cabin at Aviation museum in Kaunas (picture from personal album of L. Kaminskienė).

field studies centres has been developed. Zaragoza and Fraser (2017) refer to Harington (2001) who differentiates formal and informal learning environments. The latter is associated with learning outside the classroom, in museums, zoos and specialised science education centres. There are various definitions of field studies. Some of them are close to the concept of school journeys (Krepel, Durrall, 1981), pointing out that field studies are school trips with an educational intent, during which students interact with the setting, displays, and exhibits to gain an experiential connection to the ideas, concepts and subject matter. Obadiora (2016) provides rather a general definition and suggests that a field trip is any teaching and learning process carried out by a group of people outside of the classroom environment. We consider that Zaragoza and Fraser (2017), Harington (2001) and Rickinson et al. (2004) provide a more precise definition of the field studies as they link field studies with a specific curriculum (most often science education) to be implemented in special education centres. Some interesting examples could be found in the Aviation museum in Kaunas (Fig. 1).

Rennie (2007), as well as Behrendt, Franklin (2014), distinguish two types of field trips (they are actually very much the same as school journeys): formal and informal. Formal field trips are usually organised to museums, centres and government agencies, and bear an initially pre-organised character. In most typical cases, these programmes are implemented by the staff of the centre or the museum, thus bringing the teacher and students into a similar position.

Moreover, the experience of such field trips is rather similar to all due to the formal programme the students go through. Researchers, however, stress that informal field trips open very wide possibilities to learning and in such a case experience is very diverse as there are no pre-arranged programmes and every student, as well as the teacher, become co-creators of the unique experience.

## Outdoor adventure activities

Attarian (2003) claims that the origin of adventure programmes can be traced to organised camping, environmental and experiential education movements. Rickinson et al. (2004) notice that outdoor education for many researchers and practitioners is linked to adventurous activities such as mountaineering, climbing, orienteering and canoeing.

Attarian (2003), referring to Hale (1975), indicates that by the mid-1970s, over 190 adventure programmes were operating throughout the United States, with over half of the programmes found in college and university settings. Since then, the number of outdoor adventure programmes has been continuously growing. For example, quite recently, Allan and McKenna (2019) noted that outdoor adventure programmes have been implemented in higher education institutions to reduce students' resilience. In the UK, the outdoor adventure activities date back to the 1920s and have had significant associations with the military aims, particularly for boys, preparing for the challenges of the British Empire.

## Action research

Action research, according to Gruenewald (2003), brings teachers and students to a situation which requires rethinking the existing practices and initiating specific action. Gruenewald (2003) treats action research as a democratic process that also develops a sense of ownership of the place as well as socially active personalities, not indifferent to what is happening around in the communities. The most important in this approach is that students are facilitated through the learning process that requires identification and analysis of the situation, the problem and the context, and while initiating a specific action, they experience it individually and collaboratively. In many aspects, this educational approach is very close to another educational tradition, known as service learning. Action research allows students to realise that places are also results of social constructions, and thus planning actions that may bring change or ensure conservation of the situation puts students and teachers of the school in close contacts with local communities. What is also significant in this educational

process is that the role of the teacher is changed. Beames et al. (2017) states that outdoor education puts teachers and students in similar positions and opens up new collaborative possibilities and co-creative practices. Action research as one of the outdoor education approaches is flexible and open to combine other pedagogies, including natural history and cultural journalism. Thus, the teacher's role is to facilitate the reflection and investigation process, however, without usurping a dominating position.

## Cultural journalism

The purpose of cultural journalism, as Gruenewald (2003) explains, is to create connections between teachers, students and the cultural life of the communities. The popular Foxfire programme has initiated schools to bring children to communities for gathering stories, interviews about local cultural life and producing journalistic pieces such as articles, journals and books.

Cultural journalism has a strong phenomenological background as it allows children to understand and discover how cultural life is developed, perceived and affected by local people; what are culture and people interactions; and how cultural traditions, cultural identities, have been developed over the time.

Graham (2007) notes that cultural journalism mediates interconnections between the learners, teachers and cultures within the community. From his point of view, cultural journalism is a powerful tool or media to analyse and understand local cultures and places that resulted through human activities. Moreover, cultural journalism does not only rely on "verbal" and communicative acts, but also involves analysis of visual culture artefacts, objects and commodities of everyday life of people. Graham (2007, p. 382) provides very interesting cases how cultural journalism could be successfully used in art education:

> *As an example, high school students in a diverse suburban community created a photographic documentation of the stories of local immigrants through studio portrait photography and interviews. The teachers introduced students to important issues of multiculturalism, social justice, and documentation through films such as Born into Brothels (2004) and El Norte (1994). The students learned the technical aspects of studio photography as well as various approaches to conducting an interview. The project took the students into places in the school and in the community where they had never gone before. The students' personal journeys were given a public audience when the photographs were exhibited in the town library, accompanied by excerpts from the interviews. Their carefully crafted work honored the experiences of people whose contributions and voices are sometimes silent.*

It is not only urban areas that potentially unlock a huge variety of material for the learners, but also natural environments with, for example, ecologically sustainable patterns from indigenous local cultures.

## Outdoor education and problem-based learning

We can argue that problem-based learning is more than just a method; it could be better defined as a pedagogical strategy. Outdoor education is closely related with problem-based learning, which continues to remain one of the most popular methods and approaches of learning in various educational levels, starting from early childhood education and leading to higher education. Problem-based learning is closely interrelated with such pedagogical strategies as inquiry-based learning, service learning, sustainable education, etc. It is extremely useful for outdoor education activities, notwithstanding where it is organised: in the school settings or places outside the school environment. Problem-based learning is defined as a learning process that is organised in small groups and the purpose of which is to solve the problem through discussion (Wood, 2004); it is the process that takes place in a group collaboration in order to find out as much information as possible, by applying new knowledge to solve the problem. Problem-based learning is an interaction between the learners and the teacher, who works as a tutor, as a facilitator of the learning process. The strength of this method is that it leads learners towards self-directed learning and aims to engage them in the problem-solving process encouraging to identify knowledge gaps; this is a learner-centred learning and based on continuous discussion to solve the problem (Barell, 2007). According to Graff and Kolmos (2006), problem-based learning is effective because it covers all processes within the organisation, helps to anticipate potential threats, and enables them to address these threats timely and properly.

The goal of problem-based learning is manifold. O'Brien and Caroll (2015) present several key goals, starting from developing new skills, learning to work in teams, increasing learning motivation, and deepening problem-solving skills. Through these practices, the learning process, which involves developing critical thinking, acquiring analytical and evaluation skills, developing tolerance, accepting different approaches and perspectives, becomes a natural process.

The typical phases of problem learning involve state-of-the-art analysis, including clarification of concepts, existing knowledge and clear definition of the problem; then it leads to metacognitive processes, which are enhanced by brainstorming, group discussion, mind-mapping and other collaborative

methods. After these preparatory and "warming up" phases, problem-based methodology is constructed to stimulate analysis of possible solutions of the problem, analysis of alternatives, and analysis and discussion of new knowledge that is needed to solve the problem. The cycle is finalised by meta-reflection activities and systematisation of the applied knowledge and solutions. Typical steps in the implementation of the problem-based learning could be organised in the following sequence:

- *Exploring concepts* that are unknown, incomprehensible for learners. Learning of/about the problem presented by the teacher involves identification and clarification of the main concepts so that unawareness would not impede proper understanding of the problem.
- *Finding the cause of the problem*. At this stage, the learners are faced with a problematic challenge that encourages them to raise questions and become more familiar with the problem. Learners need to make a number of hypotheses to predict the causes of the analysed problem.
- *Using the 'brainstorming' approach* – Learners use their existing knowledge to identify possible solutions to the problem. Based on their past experience, they need to identify where they lack knowledge to fully solve the problem. Possible solutions are recorded (visualised, reported, etc.) and used for further processing.
- *Second and third step review* is needed for each member of the group to analyse, systematise the results of the second and third steps to create a solution system.
- *Formulation of learning objectives*. The teacher/tutor must ensure that the learning objectives are realistic, achievable, clear, specific and relevant to the possible solution of the problem.
- *Independent work of group members*. Learners look for relevant information related to learning tasks. The information must also be reliable and practically applicable for solving the problem.
- *Systematisation of results and meta-reflection* is the last phase, which facilitates the members of the group to share the information they found while working independently. The resulting information is systematised and combined into a single solution that will be applied to the problem. After the whole process, the learners talk about their experiences, the positive and negative aspects, what they have learned, and what they have acquired to use in future situations and contexts.

When solving complex issues, it is important to look for a logical and reasoned solution to the problem, which means that there is a need for continuous

analysis, which is achieved by already available knowledge. This learning is like a closed circle, forcing new knowledge to spin when a problem is solved, because when new knowledge is applied again and again, problems arise, which make the process permanent, unstoppable. It can also be noticed that problem-based learning encourages constant thinking, as each part of the process requires new ideas and thoughts; in other words, the process liberates the person and promotes cognition. The process only reaffirms that knowledge is at the heart of problem-based learning, as learners who are unable to apply knowledge cannot implement and participate in the process as full-fledged participants. Learning through problem-based learning is not only about the process, but also about the problem. The problem selection process is a responsible moment because the problem has to meet the needs and experience of the learner group. Working collaboratively on a problem may cause a variety of challenges, particularly when learners, meeting for the first time, are often distrustful and reluctant to cooperate. Therefore, it is necessary to clarify the relationships between learners and their experiences (O'Brien and Carroll, 2015). The chosen problems must be complex, potentially produce a measurable impact on the individuals and the organisation, and relevant to the entire learner group so that the learners have the basic knowledge and ability to analyse the problem; important to the learners' work and useful for their future. In other words, the problem must be qualitative, thoughtful and real, in order to become a learning stimulus and a source of new knowledge.

Problem-based learning has its advantages and disadvantages. Knowledge that is acquired during problem-based learning is not superficial as the whole learning process is focused on developing the ability to learn independently – learning is organised and driven by the learners. Problem-based learning is also useful for the development of collaborative skills – knowledge sharing, teamwork, ongoing discussion; it stimulates more active learning – learning which is not passive because it requires communication, discussion and critical analysis. This pedagogical strategy helps to improve time planning skills: problem(s) should be solved within a limited scope of time. It also improves managerial abilities – each member of the group must test the position of the leader, supervise the process, manage the time and encourage the involvement of each participant. Problem-based learning enhances lifelong learning competence – the acquired knowledge is not short-term, it is future-oriented, because the learners' knowledge covers a broad context. In conclusion, the stated benefits promote students' responsibility and a flexible approach to failure by providing opportunities to learn from ones' own mistakes.

Problem-based learning has also weaknesses related to the risk that the learners' discussion can become formal, without trying too deeply to solve the problem. Insufficient experience in this type of pedagogy may lead to the situation when a learning process become superficial or dominated by the teacher or one or more learners – other members of the group are not encouraged and involved. Yeo (2008) states that lack of experience, skills and knowledge impedes the proper implementation of the process, since problem-based learning requires both – knowledge and skills – to properly implement it. Similarly, learners themselves may become barriers to the quality of the process, as individuals may tend to dominate, control and compete, thus preventing others from entering the process and learning. Competition, if not controlled and properly monitored by the teacher, can disrupt the learning environment and prevent others from achieving positive and rewarding results.

In summarising the peculiarities of problem-based learning, one can say that it is the learning that reduces alienation among learners because all individuals are involved in the process of empowering them to become active. Constant reflection on the problem affects the person individually, which means that he/she cannot be passive during problem-based learning and thus seeks to make the process and the existing activities meaningful. Problem-based learning does not exclude the personal experience that is already available, as the key is to integrate learning into everyday activities so that individuals can be satisfied with the learning process, not just the end result. Stability also prevails in this model of learning, as individuals are equal partners in the process; there are no different roles that could cause conflict in the future. The analysis of problem-based learning also distinguished the importance of identifying knowledge gaps, as each learning session must add new knowledge to the person, important for continuous progress.

## Impact of Outdoor Education: Cognitive, Affective, Social/Interpersonal and Physical/Behavioural

Numerous studies suggest that outdoor education linked with community-based education brings positive impacts and shows much higher students' engagement and motivation in the learning process. Beames et al. (2017) speaks about meaningful engagement, which is nowadays one of the main challenges for educators. There are studies showing that outdoor education contributes well to students' competences, including analytical capacities, problem solving, leadership, team working, decision-making, etc. Beames et al. (2017) claims that outdoor education might bring students to real life situations that demand

psycho-motor, cognitive and socio-affective efforts to be employed, and subsequently meaningful engagement develops with each other, communities, environments, objects, etc. Similarly, Jordet's (2010) model of school-based outdoor learning clearly shows the links of bodily, sensual and cognitive processes, which take place while students are actively exploring phenomena. Moreover, social and communicative factors are extremely important, as the learning experience should be articulated and communicated, thus developing students' social capacities and bringing education to widen a community context in general. In favour of place-based education, Gruenewald (2003) and Thornburn and Allison (2010) also speak about identity development, rethinking of values, preferences, development of global and local thinking, cultural awareness, broadening understanding of power relations and regional (bioregional) dimensions.

Surface (2016) addresses to the work of Robert Marzano, who cited over forty studies from the 1970s through 2002, which proved that a positive motivation is supported when the learning process integrates and converges messages from homes, communities and schools. Coleman and Hoffer (1987) claim that in such cases students' academic performance and achievement improve and motivate their further learning. It is important to say that this results not purely from the use of different learning environments, but diverse communities as well. These findings support constructivists' ideas that outdoor education, or in a more general sense – place-based education, integrates places and communities, thus bringing students to meaningful construction and understanding of the surrounding world.

Rickinson et al. (2004) analysed research studies regarding impacts of outdoor education. They grouped these impacts into four major categories: cognitive (knowledge, understanding and other academic outcomes), affective (attitudes, values, beliefs), interpersonal/social (communication, leadership, teamwork) and physical/behavioural (physical fitness, personal behaviours, etc.). Nundy (2001, p. 4) indicated that three major benefits could be associated with fieldwork: (i) learners involved in fieldwork develop their self-confidence, there is a positive impact on long-term memory, recall, knowledge and understanding; (ii) real tasks during fieldwork contribute to the personal development of pupils, enhancing qualities of leadership, perseverance, reliability, initiative, co-operation and confidence, pupils become motivated; iii) fieldwork also reinforces links between the affective and the cognitive, each influencing the other and providing a bridge to a higher order learning. As Nundy (2001) points out, pupils who are learning outdoors and undertaking real tasks that

are self-motivating learn at enhanced levels compared to pupils who learn only within a classroom context.

Many research studies indicate increased motivation of learners, for example, Zaragosa, Fraser (2017) analysed how outdoor education made impact on the motivation of learners with different English proficiency and sex. Their research shows that in most cases the learning motivation was much higher outdoors as compared to the same activities in the classroom. Another research, carried out by Cwikla, Lasalle and Wilner (2009), highlighted that the eighth grade students who raised their interest in science during field trips and other related outdoor activities were more likely to take careers in science.

Research indicates that outdoor education has positive impacts on pupils' creativity. McAnally et al. (2018) assessed the effects of an outdoor education programme with no or limited access to electronic media among 14 year-old boys. Researchers compared creative thinking, socio-emotional wellbeing and materialism with their peers attending regular classes at their normal school. Boys were assessed twice, and the results showed that boys in the special programme outperformed those in regular classes on a creative thinking task. Fig. 2 summarises the reviewed literature, which suggests that in most cases, outdoor education brings positive impacts to the holistic development of personality, developing different domains, including five main domains such as cognitive, social, affective (emotional), behavioural (physical) and personal.

In the last years, several studies have been performed in Finland, which also focused on the impacts of outdoor education and how activities out of the classroom support the development of the 21st-century skills: creativity, critical thinking, communication and collaboration (studies performed by University of Helsinki, University of Eastern Finland and other institutions). The data support evidence that learning in different environments has an impact on the development of the person's identity and metacognitive skills. Salminen et al. (2016) presume that this might be the reason why it is quite a challenge to measure individual learning outputs outside the classroom settings.

## Outdoor Education and Educational Tourism

Similarly to outdoor education, the definitions of educational tourism also vary. One of the definitions, proposed by Ritchie et al. (2003), associates educational tourism with the desire to learn, and learning might be a primary or secondary motivator to travel. Educational tourism can be adult study tours, international and domestic university and school students' travel, including language schools, school excursions and exchange programmes (Ritchie et al.,

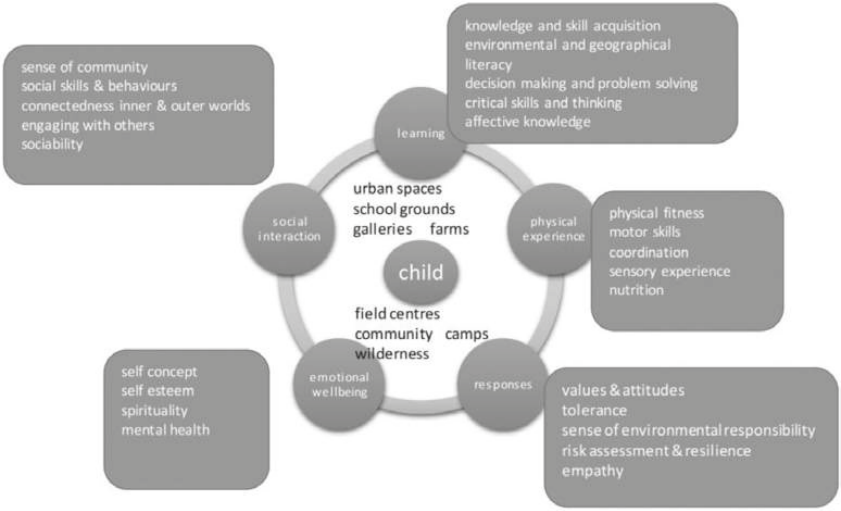


**Fig. 2:** Positive impacts in the five domains of child development (Kaminskienė, 2020, adapted from Malone, 2008)

2003, p. 18). Educational tourism is proposed to be analysed and understood through a segmentation process of tourism and education fields. Pitman et al. (2010, p. 220) suggest avoiding segmentation and consider educational tourism as specifically organised tours which promote an intentional and structured learning experience. Thus, according to Pitman et al. (2010), learning is a key component. Providing an overview of conceptual discussions of the definitions and components of educational tourism, McGladdery (2016) proposed a process model of educational tourism, which views educational tourism as a transformative experience. McGladdery and Lubbe (2017) argue that effective learning might occur when clearly defined and appropriate learning-stage outcomes (cognitive, affective and behavioural) of the process are developed.

A literature review of outdoor education and educational tourism helps to identify similar characteristics and even definitions of both concepts. However, taking into consideration that educational tourism involves at least two segments – education and tourism, it would not be possible to put educational tourism and outdoor education on equal sides. Outdoor education is one of the forms how place-based education is implemented, and has a very strong idea of education outside the school/classroom. Educational tourism, however, is not so much focused on activities outside or inside, but rather on the unique

learning experience. Three main components link outdoor education and educational tourism: place, learning and curriculum, both formal and informal.

Educational tourism has many similarities with school journeys, excursions, field studies and field trips; however, it is a broader concept as it may also involve students' travel, language schools, etc. Historically, educational tourism has more links to education of the bourgeoisie, whereas outdoor education is very much linked with natural history and gender issues. Notwithstanding these ontological differences, outdoor education and educational tourism focus on specific real/virtual/imaginative places, where people have to travel/visit or experience something new. From this point of view, both outdoor education and educational tourism are closely linked to a broader concept of place-based education; however, we cannot put educational tourism on the same line with other educational traditions, such as experiential learning, sustainable education, contextual learning, etc., for the reason that educational tourism is a trans-sectorial concept linking education and tourism.

From the pedagogical point of view, outdoor education and educational tourism are important while providing diverse contexts of learning, and thus contributing to the realisation of specific curriculum. Outdoor education and educational tourism, as research suggest, have similar impacts on participants and result in most cases in positive changes in cognitive, affective and physical/behavioural domains. Fig. 3 illustrates links of place-based education and educational tourism that go through all dimensions, including theoretical backgrounds, educational traditions, schools and pedagogies.

For further development of educational tourism, it would be useful to refer to three outdoor educational landscape approaches proposed by Sandell and Öhman (2013): active domination, active adaptation and passive adaptation. Even though these strategies are directly linked to sustainability and environment concern, they could be potentially expanded while exploiting possibilities of urban areas, villages, museums, etc. Active domination is a strategy that treats the existing landscape and environment as "a factory" and should be adapted by using various facilities and measures by creating the necessary infrastructures or providing and expanding activities/services that optimise the best use of the place. Active adaptation is somehow similar to domination but is limited and subordinate to the landscape (time of the year, etc.). Passive adaptation implies studying and adapting the landscape, but without major interventions or changes to it.

Other strategies highlight the importance of integrating arts in outdoor education. Grimwood et al. (2018) describe that urban outdoor educational

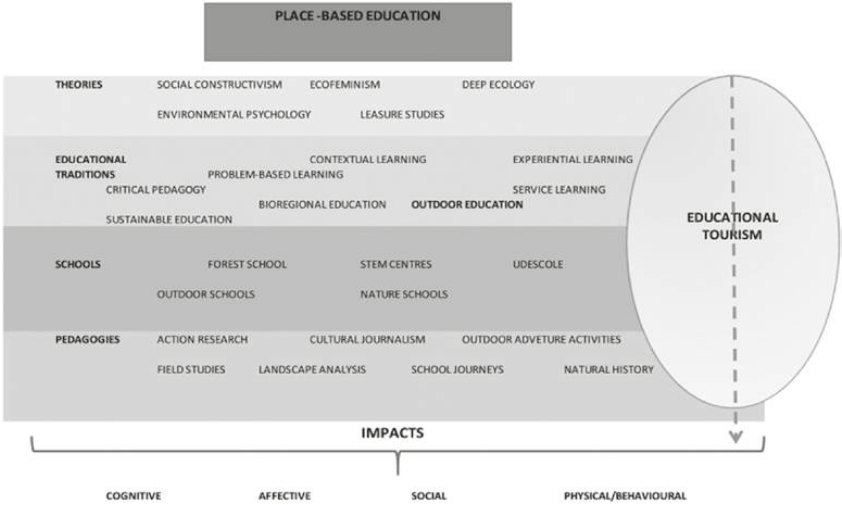


**Fig. 3:** Dimensions of place-based education and its links with educational tourism (Kaminskienė, 2020)

programmes become more effective when successfully combined with dramatic performances, songs and storytelling.

Changes in the national curriculum also change the profile of museums, libraries and other public institutions. As Salminen et al. (2016) note, in Finland library-school collaboration has witnessed changes from simple field-trips of school groups towards the development of libraries' pedagogical services. Accordingly, today modern libraries are places where a variety of school-oriented services has been developed. With the spread of innovative pedagogies and expansion of the concept of learning, museums have changed their approach to their groups and expanded their audience, creating the necessary infrastructure and facilities for diverse audience, including students with special needs. A significant change has occurred in communication and media used within museums, which was also very much influenced by the increased groups of students from wide age groups. As Salminen et al. (2016) indicate, museums, in addition to their traditional methods such as talking and writing, have adapted media, which uses all the senses.

## Outdoor Education in Different Educational Levels and Contexts

In the last decades, the concept of place-based education brought new projects and teaching approaches into the education field all over the world. Contextual learning and service-learning practices were successfully implemented and spread over different types of education institutions in the USA, Asia (Komalasari, 2009) and European countries. There are no studies indicating that outdoor education or place-based education has limitations to certain age groups or educational levels. Studies revealing the potential of outdoor learning (Glynn, Winter 2004; Becker et al.; Monkevičienė et al., 2018) range from kindergarten, primary to tertiary level education.

### Outdoor education in kindergarten

Studies show (Katz, 2010) that children learn mostly about nature, technology, engineering, while being in an environment that encourages to experience, research, experiment, collaborating with adults who raise questions, draw attention, and encourage interest. Therefore, it is important that children in pre-school facilities have the opportunity to be outdoors, in an open space with numerous challenges, objects of study and diversity in their daily activities. Children should have natural objects such as trees, shrubs, grasses and large stones, whose qualities they can learn by observing and exploring. It is also important to have real objects that can be manipulated – boards, building blocks, pipes, canvas cuttings, plates, sand, logs, cushions, as well as work tools such as spades, brooms, etc.; by manipulating these big objects by the laws of physics, they discover gravity, friction and understand structural solutions. When children are able to use different systems that include movement – wind, water, sand, balls – they can explore the laws of motion. The ability to analyse various mechanisms enables them to get acquainted with engineering solutions. Developing and expanding understanding about the natural world becomes possible by exploring the plants in the yard of the preschool, exploring the world of beetles, and caring for pets and wild animals (e.g., feeding birds in winter). Children's experience expands during their visits to spaces outside the preschool to help them discover the world around and develops their sense of responsibility towards the place they live.

Outdoor education in Lithuanian kindergartens is witnessing a renaissance. More and more pre-school institutions implement outdoor education programmes, which means that educational activities are transferred to

outdoor settings, both in kindergarten and out-of-school settings. In this way, the environment is perceived not as a continuation of the internal environment, but as an impressive place for the child's experiential education, research and self-expression.

Outside the classroom, there are opportunities to get to know the environment in various ways: by researching it, finding answers to the questions raised, creating problem situations and solving them, finding relationship between causes and consequences, and most importantly – learning is realised through all the senses.

Several cases from kindergarten education present interesting examples how outdoor education contributed to the development of various competences related to pre-school curriculum. These cases were collected as part of the national research project during April–October 2018, guided by Prof. Ona Monkevičienė and the team (Monkevičienė et al., 2018). Three examples presented below demonstrate how different outdoor education is implemented in Lithuanian pre-school education institutions. One of the examples demonstrates a project in Palanga Municipality.

> *And the director offered me to take part in it, but I had to come up with the idea myself. Since our focus is on strengthening health, we are thinking about what new methods we could use. And the idea of a borderless education came up…*
> *According to the project, we visited the sea with the children, we read the story "Jūratė and Kastytis" there, we talked about this piece of literature. Before that we bought the amber for the children, we poured down those amber, and they gathered them home. From the seashore we picked pebbles, then we painted on them at the kindergarten. And throughout the spring, education was held outside the class.*
> *If there was a dew in the morning, we put on boots and we travel. We read stories outdoors and look for beetles. At first, we used plastic and paper beetles, and everyone was looking for, finding and putting in the bag. And then we named them, discussed. And after the rain we walked and found all kinds of real beetles, crows, snails. We also discussed how fluff is formed, what is dandelion milk… we are still planning to travel to the forest. And we plan to find treasure in the forest. We anticipate walking on dangerous paths, playing games in the forest. We also plan to go to the stone park. Then we want to make a stone exhibition with our parents, which is called "Let the stone speak"… So we are out in the morning after breakfast. And the morning lessons outside the class….*

This interview presents a nice combination of several types of outdoor education. We can find elements of natural history (analysing dandelion milk, snails, etc.), landscape analysis (going to the forest, to the sea), and some elements of outdoor adventure activities (walking on dangerous paths, playing games in the forest). Unfortunately, the interview does not go into detail what kind of

competences were developed during these activities and what impact on cognitive, affective and physical abilities was achieved. Still, it can be identified from the interview that teachers managed to develop linguistic and literature analysis skills by going to the sea and discussing the poem, which lyrically explains how amber was created in the Baltic Sea area. Botanical knowledge is also an important part of outdoor education. Much attention is paid to physical education and health.

> *Our long-term project "Traveller to Lithuania: I know, explore, discover". We've already got well acquainted with Vilnius and that is why we went to many other places: museums, centres, and more. Now we go to Trakai, Anykščiai (bread baking, horse museum), there is such a bird village in Ignalina region. Every excursion is a stimulus for new tasks for children. Before we travel, we inquire about what we are looking for on the Internet, contacting those organizers, we already know in advance what the activities will be and we will come up with what they need to discover and learn. For example, when we were baking bread at the horse museum, getting acquainted with the ancient utensils, tasting those Lithuanian meals, kneading the bread ourselves, each shaping our own loaf, we tasted it, enjoyed the smell . . . And there are so many birds, animals and even some not seen in the bird village. . . . the children could feed them. . . Also, the kids could understand how the chicken are born because there was a hen in one place, sitting on the eggs, in another place with a few days of chickens, followed by a grown-up chicken . . . And then we're discussing everything we saw in the group: and we have used the encyclopaedias, and we draw and discuss.*

The second case has more connection to what was defined as field studies and educational tourism. Children learn to study and observe the environment during excursions, and they become more aware of the interrelation of different phenomena. It gives children unique moments of knowledge of the nature, and creates natural conditions for observing, exploring, discovering, contemplating, summarising and experiencing everything they have learned. Excursions are not limited to the hometowns. There are interesting cases when children and teachers go to various nature monuments, to regional parks, ethnographic homesteads and so on.

> *This year we started out activities in regional parks. Education has no borders, and everything can be learned in nature …. When we arrived at the New Vilnia barrow, the teachers reminded the children how to behave in the forest, what are the basic rules of warning signs. Starting the journey through the park, each group of children received a basket, where they picked cones, acorns, leaves, etc. during the whole walk. When they climbed the barrow, the children found a stick-curse which they used throughout the trip "In the Kingdom of Trees". Each group during the walks picked one or more of the trees they liked and studied them: measured the volume of the trunk; analysed the leaves, etc. The educators told and showed how to learn the age of the trees. We brought a piece of*

*a tree trunk and we counted the year, compared it with the trunks of other trees. . . The children looked at the trees from all sides, found the differences, discovered how to learn the directions of the world using the compass. The teachers explained how this affects the trunks of trees.*

The third case again presents how natural studies could be organised. Though it is mostly limited to botanical knowledge, some elements of geography (parts of the world) are also introduced. Nevertheless, these cases from pre-school education show that early age outdoor activities lack connections with communities and do not involve cultural analysis. Outdoor education activities are more focused on specific knowledge of the landscape, monuments and places; however, they lack interaction with local people. Children communicate in groups and with teachers, following pre-arranged learning programmes or plans.

## Outdoor education in primary, lower and upper secondary schools

The majority of research on outdoor education (Cwikla et al., 2009; Obadiora, 2016; Zaragosa, Fraser, 2017; Grimwood etl. Al., 2018) provide cases from the primary, lower or upper secondary education level. This could be logically explained that the age group from 7 to 18 is "good clay" to apply different educational strategies in outdoor environments. Several cases from a Lithuanian gymnasium reveals that teachers are willing to bring students to different places that allow to link theoretical learning with real places and real personalities, communities.

*After visiting B. Sruoga Museum expositions, students worked in groups on practical tasks about the writer's life and his creation, including historical and cultural conditions of that time. During the Lithuanian language lessons they analysed the work of B. Sruoga in more detail, and also prepared the project work which students presented to the gymnasium community.*

This case already presents a complex of pedagogical approaches linked to outdoor education. Literature museums are a good place where students can deepen the knowledge gained at school. Non-traditional learning can help to discover attractive activities; develop personal, social and literary competences for everyone. The museum environment creates preconditions for the creative activities of students of all kinds.

*So we applied the idea in V. Žilinskas Art Gallery by participating in the educational program "Fun by the Greeks". Not only did the pupils get to know the Antique culture, but they also created myths and staged them. Masks, unconventional space allowed gymnasts to improvise, read and create texts. Everyone could choose roles according to their abilities. After the lesson at the V. Žilinskas Gallery, the pupils individually*

*performed the practical task during the Lithuanian language lesson at school - they described, evaluated the chosen mythological personality and searched for their correspondence in the works of Lithuanian poets.*

Grimwood et al. (2018) describe a case of urban outdoor education programmes. Most of these programmes took place within Toronto parks and green spaces. They included community-school and after-school programmes, as well as weeklong summer day and residential camps, targeting ages 4 to 14. The study revealed a positive attitude of educational instructors towards the urban outdoor education programmes, which shows that outdoor education is not limited only to natural landscapes.

## Implementation challenges

One of the main challenges addressed by researchers is related to teachers' competency and their readiness to implement outdoor education in practice. Notwithstanding the fact that most of the schools use outdoor education as a supplementary pedagogical approach, in rather typical cases, as Maynard and Waters (2007) noted, teachers tend to use outdoor environment in a partial or limited way. It seems that teachers feel rather uncomfortable with outdoor education as it relates to the implementation of formal curriculum and consider it as part of non-formal education. As discussed in this chapter, studies show that outdoor education contributes to positive impacts on children's development.

Salminen et al. (2016) stress that in Finland teachers are taught to utilise diverse learning environments and not to concentrate on class as the only space where successful learning might be implemented. As the new national curriculum is considerably flexible and is focused on phenomenon learnings, this inspires and facilitates utilising different environments, including museums, libraries and other public institutions, which could become a very meaningful source of learning new things and contextualising them. On the national level, teachers received support through several projects which were oriented to the collaborative practices between schools and public institutions. Despite the growing number of outdoor learning activities in Finnish schools, the researchers admit that there is no official Finnish statistics on how often different learning environments outside the school environment are used.

Another challenge related to the implantation of outdoor education is discussed by Dyment et al. (2018) and relates to the pedagogical content knowledge of outdoor education and pedagogies that should/might be employed to achieve the defined goals. Researchers argue that similarly like other subjects (for example, mathematics), outdoor education has its own subject content, and

teachers, as well as outdoor educators, should have competence and experience to implement outdoor education in a successful way. Dyment et al. (2018) proposed a framework of pedagogical content knowledge for outdoor education following the analogue of the framework developed for teaching mathematics.

Fägerstam (2013) identified several potentials and obstacles for outdoor education. Firstly, expectations related to implementation of outdoor education raise much higher expectations than this type of education is realised in practice by teachers. So, one of the challenges is to prepare teachers and to set realistic objectives and learning plans. Collaboration among different teachers is also considered as one of the advantages in outdoor education, and this collaboration might help to reduce boundaries among different disciplines. However, the research indicated that the raised expectations were not fully realised, and the implemented pilot outdoor education activities did not increase interdisciplinarity; besides, no stronger collaboration among teachers was observed. Fägerstam (2013) study explains this by lack of time and difficulties in planning, very limited possibilities to go further from school areas as it also requires much more time than the planned school curriculum allows to do. Notwithstanding the identified obstacles, the study shows that outdoor education enhanced participation and collaboration in the class as well as the relationship between teachers and students changed in a positive way.

## Outdoor Education in the Context of Developing Educational Tourism in Visaginas and Ignalina Nuclear Power Plant

Outdoor education can take place in different contexts, but through distinctive spaces, outdoor education can contribute to the development of educational tourism in the regions that traditionally or for a long period of time have not been classified as places for tourist attraction. One of the interesting examples of educational tourism development is the city of Visaginas and the Ingalina Nuclear Power Plant. These specific spaces – the city and the area of the nuclear power plant – were developed during the Soviet period. This particular historical period and the fact that workers and specialists from different parts of the Soviet Union were involved in the construction of the power plant contributed to the result that the majority of the population in the city is Russian-speaking and of other nationalities. For more than forty years, Visaginas has become a kind of ethnic, cultural and linguistic island in Lithuania. The completion of Ignalina Nuclear Power Plant decommissioning is planned for 2038. When planning these decommissioning processes, it is important to define and ensure a further development of Visaginas city, which defined itself as a nuclear city

and as a satellite of the Ignalina Nuclear Power Plant. The decommissioning processes have a direct impact on the social, economic, cultural and identity development of the Ignalina Nuclear Power Plant region – there is a need to reconceptualise and reconstruct urban and regional identities. Moreover, the city has not yet developed its economy, which has been dependent on the power plant for the last forty years. Nuclear tourism is one of the economy development strategies for the city and the region, which may adapt international experience from Europe, Japan, the US and other countries. However, nuclear tourism cannot be successfully developed without attractive concepts behind it. These concepts, as international experience shows (Mažeikienė, Gerulaitienė, 2018), have a strong link with educational goals. These educational goals may stimulate the development of nuclear tourism within the region, taking into account the geographical position of the city and Ignalina Nuclear Power Plant. The city and the plant as tourism and "educational centres" have high potential to attract pupils and students from the whole of Lithuania as well as neighbouring countries, mainly Latvia, Belarus and Poland.

The Ignalina Nuclear Power Plant was built in the area that is interesting for a variety of reasons: geographical landscape, the plant and the landscape affected by the human activity, historical perspective (the Soviet period), energy production and the role of the plant in Eastern Europe, post-Soviet countries, etc. All these aspects create an inexhaustible source for outdoor education activities.

Outdoor education, as discussed earlier, has a variety of ways how to be implemented: through school journeys, action research, problem-based learning, etc. We will discuss how Visaginas and Ignalina Power Plant context and the place can be successfully used to develop outdoor education activities on the one hand, and contribute to the development of educational tourism on the other hand.

The city of Visaginas is a very interesting place for exploration by applying such methods as cultural journalism, field studies, action research, problem-based learning and other pedagogical strategies. Cultural and ethnical uniqueness may be analysed by applying the method of cultural journalism. Learners could be assigned to analyse and record different signs in the city and try to understand what the city is "communicating" through signs, adverts, textual, visual or audio information and media. The city could also be analysed through different perspectives: historical (and then the communication of the city is important through cultural representations and archives, old newspapers and journals, documentaries that could be accessed in the library and/or other institutions); the historical perspective and story can be enriched by interviews of local people. Another perspective could be cultural; the city of Visaginas

could be analysed as a multicultural place, and students could explore which acculturation strategies have been employed by local people (using time perspective yesterday and today). Cultural journalism, as described earlier in this chapter, is an extremely powerful method, which generates a vast amount of resources and information. These resources sparkle imagination and might be potentially exploited for developing tourism attractive places in the city, offering unique stories, events, etc.

One of the examples, how outdoor education can be implemented and supported with technologies, is illustrated by the following case. Emokykla (E-school), an e-learning platform, offers assignments related to Ignalina region. These assignments can be used during geography lessons for grades from 6th to 8th. Ignalina region is characterised by a spectacular landscape that was formed by the last Ice Age. The e-learning platform offers pupils to create a comic about how the site around the Ignalina Nuclear Power Plant has changed. The pupils are encouraged to describe what new components of the landscape have emerged, how they have changed the environment, and how the plant has affected the wildlife. The pupils can also virtually predict how the Ignalina region will change in twenty years after the closure of the Ignalina Nuclear Power Plant. The above-presented assignments can be done with or without visiting the place of the plan; however, deeper learning will be achieved if we combine both, e-learning and landscape analysis.

Mažeikienė and Gerulaitienė (2018) indicate that regions around nuclear power stations are also well known as nuclear tourism destinations. According to these scholars, "new forms of nuclear tourism" encourage schools to organise educational visits to power plants and the museums or tourism centres in these areas in order "to give understandable and unbiased scientific information about different topics: atoms, radiation, ionizing radiation and health, reactors, robots, physics and much more" (Mažeikienė, Gerulaitienė, 2018 p. 5674). Following these researchers, obviously, Ignalina Nuclear Power Plant is a place to enlarge knowledge in STEM subjects, including physics, chemistry and technologies. However, not less important is the fact that nuclear tourism places bear a mystified character, which stimulates imagination of tourists, willing to discover "dark" and mysterious stories related to the power plants. Thus, from the educational point of view, Ignalina Nuclear Power Plant as well as its satellite the city of Visaginas, offer a vast amount of information and almost unlimited opportunities to implement some components of the curriculum through outdoor education activities for different age groups. Obviously, this region can find its place among tourist routes in Lithuania and can be potentially integrated into a wider international network of nuclear tourism destinations.

## Conclusions

Outdoor education is not a new phenomenon; however, it always deserves attention from researchers and practitioners regarding its scope, objectives and a variety of implementation ways. Historically started as natural history, outdoor education today is evident in diverse forms and pedagogical solutions: school journeys, field trips, landscape analysis, adventure activities, etc. In the last twenty to thirty years, mainly influenced by experiential pedagogy, outdoor education has proved to be a successful approach to developing learners' cognitive, affective, social and behavioural domains of different age groups.

Outdoor education and educational tourism have common stems coming from the concept of place-based education, which has been affected by a variety of theories, including ecofeminism, bioregional development, socio-cultural theories and other spheres. Still, we cannot say that educational tourism is a form of outdoor education simply for the reason that educational tourism is trans-sectorial and links education and tourism with its own objectives to attract people to specific places (be they real, imaginative or virtual) and educate them. Even though most researchers keep to the position that outdoor education, environmental education, etc. are historically changing concepts of place-based education, there are definite differences that should not be merged and fully aligned.

Notwithstanding the fact that outdoor education suggests using active pedagogies, one of the challenges remains to prepare teachers to work in creative ways while implementing outdoor education as they tend to limit outdoor education to field trips and school journeys. Researchers also identify that school raises extremely high expectations for outdoor education, yet in practice a lot should be prepared and realised step by step. Things do not change dramatically, but the schools should be ready for a systemic and gradual development of their approaches in outdoor education practices.

The final efforts should be addressed to learners – young children, teenagers and even adult learners. There is no evidence that outdoor education should be restricted to some specific age groups, even though most outdoor education practices in many countries are focused on children from 4 to 15 years. Linking educational tourism, which attracts much more adult learners, and outdoor education, which is still more related to school education, we may get very unique synergy which will not only help us to develop important skills, attitudes and behaviours of learners, but also raise awareness and responsibilities towards the places we live. Returning to Louv's coined term "nature-deficit disorder", we should think about the advantages that outdoor education and

educational tourism might bring to our societies in terms of education, health, natural and cultural preservation, sustainability, and identities development in the globalised world. Outdoor education and cultural tourism should not be contrasted; on the contrary, they are developed in parallel, and our schools, education centres, museums, libraries and other institutions and actors should be ready for the change.

From the educational perspective, it is strategically important for Lithuania to develop nuclear tourism as it may open a variety of outdoor education activities combined with sustainable education, environmental education, bioregional education, service learning and others. More actively involving Lithuanian schools, kindergartens could contribute to raising awareness among young population about the variety of tourism and tourism concepts, enhancing learning of STEM, languages, history, economy, geography, physical and health education, arts and other subjects. Taking into account the experience of Scandinavian countries (Finland), more initiatives could be undertaken by the library of Visaginas by offering diverse educational programmes, cinema festivals, cultural programmes, etc. for different age groups.

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# 5

Odeta Norkutė and Natalija Mažeikienė

# Energy Literacy in Geography Curriculum: Redefining the Role of Nuclear Power in Changing Energy Landscapes

**Abstract:** The aim of this chapter is to reveal how different forms of both formal and non-formal education can be combined within the educational route of the Ignalina Nuclear Power Plant (INPP) seeking to develop the energy literacy by employing the geography curriculum. A general question raised in the chapter is how geography curriculum and teaching/learning geography could be improved by developing energy literacy (including nuclear literacy), applying the context-based learning approach and using opportunities of the outdoor learning environment (in this case, nuclear educational tourism on the site of the INPP). Seeking to achieve the aim, the data of the content analysis of geography curriculum and geography textbooks is presented. The analysis of texts on nuclear energy in the textbooks aims to identify the connection of textbook materials on nuclear energy to geographical skills and competences pointed out in comprehensive programmes and how it combines with the taxonomy levels of competences.

The research demonstrated that the national curriculum did not include direct connections to energy literacy; however, preconditions for the development of cognitive, affective and behavioural dimensions of energy literacy are created. In the textbooks, the theme of nuclear energy is mostly linked to the cognitive dimension, when basic knowledge of numbers and facts is obtained; comparisons of, e.g., volumes of nuclear fuel processing in different countries, changes in nuclear energy in different regions, and depiction of the process of recycling of nuclear waste are presented. The formation of other dimensions, i.e., behavioural and attitudinal (affective), is given little attention, and the development of these components is quite episodic.

**Keywords:** energy literacy, geography curriculum, energy geography, nuclear power, energy landscape, geography textbooks, The Ignalina Nuclear Power Plant, Visaginas.

## Introduction

The authors of the chapter have been working on the development of the route of educational nuclear tourism in the Ignalina Nuclear Power Plant (INPP), Lithuania. The methodology of creating the educational route implies establishing links with the formal school curriculum and attracting school

students and other learners as potential visitors and tourists with educational needs and interests to the site of the INPP.

The INPP and a town of Visaginas, a satellite town of the INPP encompassing its historical and social context, have been chosen as a field for creation of educational nuclear tourism and scientific investigation. The construction of the INPP started in 1974; the exploitation of the first block commenced on 31 December 1983. Back then, it was planned to be the most powerful nuclear plant in the world, with mounted four RBMK type reactors. However, after the Chernobyl catastrophe in 1986, construction of the third reactor was conserved, and the construction of the fourth block did not begin. After Lithuania restored its independence in 1990, the INPP became the most important part of the energy sector. In 1993, even 88.1 per cent of the electric energy required by the state was produced in it. At the time of Lithuania entering the NATO and the European Union, the condition in terms of safety assurance was emphasised; and, thus, the RBMK type reactors being exploited at the INPP were considered to be unsafe. Therefore, the power plant could not be exploited and, on 31 December 2009, its operation was completely terminated. The works of decommissioning of the power plant are projected until 2038.

The town was built near the INPP; staff and their family members inhabited it. At the beginning, the town was called Sniečkus (it was a surname of the First Secretary of the Communist Party of Lithuania); later (since 1992), the town was given the name "Visaginas". The nuclear plant was being exploited by specialists of nuclear energy who arrived from nuclear power plants operating all over Soviet Union. This formed an exceptional situation of the town in demographic, cultural and urbanistic terms. The town stands out by its multicultural aspect and specific linguistic milieu in Lithuania: residents representing 38 nationalities live here, majority of them speak Russian. This is a town attributed with Soviet architecture, historically formed as a mono-industrial site built for one purpose – to serve the nuclear industry, losing its major purpose after closure of the nuclear power plant and, therefore, undergoing the crisis of place identity.

The uniqueness and exceptionality of the INPP and Visaginas town provide preconditions for development of educational nuclear tourism, design an educational route combining means of formal education and educational tourism. The authors of this chapter raise questions: how to combine different forms of learning, i.e., the route of educational tourism and the process of formal education; how to make this route attractive and useful to students and teachers, as participants of formal curriculum; and how to combine cognition of nuclear energy and social, cultural, historical cognition.

In search for answers to these questions, the chapter displays the analysis of the geography curriculum content and the content of geography textbooks for school. Geography curriculum has been chosen for analysis as a school subject which potentially covers a range of nuclear energy–related topics. A general question raised in the chapter is how geography curriculum and teaching/learning geography could be improved by developing energy literacy (including nuclear literacy), applying the context-based learning approach and using opportunities of the outdoor learning environment (in this case, nuclear educational tourism on the site of the INPP).

## A New Role of Geography in Teaching and Learning Energy Literacy and Promoting Education for Sustainability

There is an ongoing intensive discussion in the scientific discourse on new areas of geography research and scholarship on how to translate these new areas into new domains of geography curriculum in school. Geography becomes a central school subject in building understanding and addressing current energy issues and dilemmas. At the same time, geography curriculum becomes "a curriculum of survival" and "a curriculum of the future" aiming at promoting education for sustainability and building environmental literacy (Lambert, 2013, Butt, 2011). Additionally, geography curriculum is considered by geography researchers as the most important school subject in learning about globalisation.

Researchers of education emphasise the need for teaching energy in geography classes (Thoyre & Harrison, 2016). Energy literacy enables learners to assess energy-related decisions throughout their lives: as citizens with a "citizenship understanding" in the context of local, national and global decisions, as well as at a personal level, in the context of their daily life decisions. It is believed that "energy literacy" would help equip people to make more responsible energy-related decisions and actions (for instance, to reduce energy consumption (Van der Horst et al., 2016). To implement new energy policy decisions at the national and global levels (e.g. the introduction of renewable energy technologies, climate change measures), energy literacy becomes an educational foundation that can create social support. DeWaters et al. (2013), referring to Fowler (1976), underline the importance of energy literacy to make energy-related decisions at the individual and societal levels. According to Fowler (1976, cit. DeWaters et al. (2013)), energy literacy deals with understanding the science and technology of energy and its pervasive role in the national and world society; enables to make informed political decisions on energy-related options; and to make personal life-style decisions that are consistent with energy realities.

Thus, these different decisions that citizens have to make at different levels of the decision-making are intended to have scientific literacy (including technological and environmental literacy, scientific inquiry and problem-solving skills), but social competences and abilities, i.e., ethical aspects and citizenship understanding, are important, too.

The authors (DeWaters et al., 2013) who developed an energy literacy measurement instrument to assess energy literacy among secondary school students (forms 7 through 12) distinguished three dimensions of energy literacy: cognitive, affective (attitudes, values) and behavioural (including predispositions to behave). The cognitive element embraces contents knowledge on energy and cognitive skills. The affective element implies positive energy–related attitudes, which would allow reducing environmental impacts related to energy use, economic responsibility for using renewable resources. The behavioural component of energy literacy deals with energy-saving habits, energy-consumption patterns.

## Energy Geography in the Curriculum of the Future and Survival

Many topics of energy geography are associated with environmental issues and could be transformed into education for sustainability in the geography curriculum. Authors analysing the new role of school geography call the geography "a world subject", the "curriculum of survival" and the "curriculum of the future" (Lambert, 2013, Butt, 2011). Geography is a discipline that allows us understanding the nature of globalisation, how globalisation works and what challenges and problems it creates. Geography can become a kind of an educational response to the contemporary economic and environmental crises: the global financial turmoil, the global climate change.

In contemporary geography curriculum, matters of energy are discussed in relation to global climate change by teaching about the necessity of a larger societal transition away from fossil fuels and alternative energy resources, i.e., renewable energy technologies (Thoyre & Harrison, 2016). Concerns about the environmental and economic sustainability of fossil fuel and nuclear power, energy-related environmental impacts are raised. This kind of education for sustainability seeks to educate and socialise new citizens, consumers and policymakers who become advocates of alternative energy resources. "Energy is an excellent vehicle for thinking about sustainability issues since it is imbricated in so many current environmental problems at multiple scales: climate change, air and water pollution, overconsumption, geopolitics, among others"

(Ibid., p. 33). A field of geography, "energy geography", is the "the study of energy development, transportation, markets, or use of patterns and their determinants from a spatial, regional, or resource management perspective" (Calvert, 2016, p. 104). Energy geography conceptualises energy as a social relation, and the energy mediates the human–environment relationship.

At the research level, the energy geography includes the following tasks: monitoring energy supply-chain developments; identifying place-based factors which explained observed spatial patterns of energy-sector investment; assessing environmental and economic risk, especially in the context of large-scale nuclear energy development; understanding how energy technology diffuses within and between nations; and mapping regional variations in energy production, distribution and use (Calvert, 2016). "Core topics of energy geography have traditionally included resource development, power-plant siting, land use, environmental impact assessment, energy distribution, and transport, spatial patterns of consumption, and diffusion of conservation technologies" (Solomon et al., 2004, p. 302).

Authors analysing the role of geography with its focus on globalisation (Butt, 2011) note that geography no longer emphasises geopolitics; it refers to the geo-economy as a way of revealing how global capitalism crosses borders of national and local economies. Therefore, geography allows going deeper into globalisation and patterns of global interconnectedness and interdependence. "A balanced view of globalisation must be attempted by curriculum makers, one of which takes account of its costs (for some) – unemployment, pollution, cultural change, loss of environment, resources and habitats, and poverty; but also its benefits (for others) – increasing employment opportunities, economic growth, greater exchange of goods and services, raising incomes and facilitating better access to products, services and cultures. The significance of identifying globalisation's 'winners' and 'losers', and their uneven spatial distribution, is of profound interest to geographers and geography educators." (Ibid., p. 434).

Geography, with its new focus on an analysis of global interconnectedness, turns into a discipline of cognition and potential criticism of global capitalism. Geography searches for answers to questions of how global capitalism creates inequalities, who are winners and losers of global capitalism, and how uneven spatial distribution works (Butt, 2011). Criticism of global capitalism in geography reveals general features of critical geography aiming to delineate power relations and inequalities which are produced by an uneven distribution of political, economic and social power.

At the same time, it should be noted that geography as the main school subject dealing with the understanding of globalisation in the realm of energy

geography at school and in university is interconnecting and intertwined with economic geography. Energy is an important resource of economic activities and, at the same time, the energy industry is an important branch of the world and national economies. In terms of this perspective of political economy and economy geography, long-term supply and demand, regulation and pricing of energy resources are analysed.

## The Changing Energy Landscape as the Main Concept of Energy Geography

Energy geography as an area of scholarship analyses the shifting of global energy landscapes with socio-technical (energy) transitions, spatial differentiation and territorially networked power relations (Bouzarovski, 2009). Such a definition would make it possible to attribute this geography to critical economic geography which analyses how political and economic power works and how power is distributed among power centres. The post-Communist states of Central and Eastern Europe (CEE) are considered as a specific energy landscape with the emergent "geographies" of energy reforms (Bouzarovski, 2009). These countries have been reforming their energy industries away from the legacies of the planned economy inherited from Communism towards a market-based energy regulation.

The authors analysing energy landscapes and their transitions (Dahlmann et al., 2017) focus on European Union energy policy processes which are aimed at the establishment of a single market for energy and the integration of renewables. Dahlmann et al. (2017) distinguish the following processes in EU24 countries between 1996 and 2013: an increase of the capacity for generating capacity (except for the Baltic region where a decline in the installed capacity is observed). In Lithuania, the energy landscape changed with the closure of nuclear power as a branch of the economy. Analysing the energy landscape of CEE, Bouzarovski (2009) provides data on the share of hydropower and nuclear energy in the total generating capacity of CEE states in 2005 (based on the data compiled from the US Energy Information Administration, International Energy Agency, and Austrian Energy Agency). At that time, a share of nuclear-generating capacity in Lithuania was more than 50 per cent. Since 2004, the first INPP reactor has been shut down; since 2009, the second reactor was closed.

Correspondingly, the energy sources in Lithuania are changing, and there is a decline in installed capacity. Other important changes in the energy landscapes in EU24 countries between 1996 and 2013: changes in patterns of fuel mixes

and capacity ownership (decreasing ownership concentration and a general increase in a number of (new) owners – operators). At the same time, the Baltic region is recognised as an "energy island" in Europe with a high degree of concentration of ownership and clear path dependence due to the Soviet legacy (it is a former part of the Soviet Union's energy system) and geographically peripheral location (Dahlmann et al., 2017). In 2017, the share of renewable energy in Lithuania was 25.83 per cent. This progress in the development of renewables is partly explained by the attempt to offset the overall decrease in generating capacity related to the closure of nuclear power.

**The place of nuclear energy in geography curriculum.** The topic of the use of nuclear energy in the context of geography is related to the topic of education for sustainability and the global impact of the earth as well as the health and life of all humanity. Looking at the use of nuclear energy as a global phenomenon with consequences and potential harm for the environment, it is important to raise questions about the environmental impact of using nuclear energy for energy which is one of the cleaner technologies (in terms of CO2), but the potential insecurity of the nuclear technologies and spent radioactive fuel are causing real and potentially severe damage to nature and humanity (catastrophes and disasters). As demonstrated by the Chernobyl accident, damage for nature and people has been done in both local and global contexts. These accidents and disasters as well as their negative effects create global interconnectedness. Potential harm and damage are enormous; their negative impact is hardly assessable now and in the future.

When interpreting nuclear energy as a domain of energy geography, it is important to recognise the use of nuclear energy in the global geo-economy and geopolitics. It is important to recognise how the entire global infrastructure of nuclear power is built, what countries and energy networks participate in and develop the nuclear power industry, what is an economic model of their operation and what are their geo-economic and geo-political interests. It is also important to recognise how the use of nuclear energy is incorporated into a general picture of the common energy infrastructure of countries and regions.

Energy-related topics are analysed and taught from the perspectives of critical geography. Scholars analysing energy from the point of view of critical theory highlight issues of inequality, social and environmental injustice, implications of different energy regimes for communities who have differing amounts of power in larger political economic and social systems, energy vulnerability and resilience, and the energetic political economies of power and control (Thoyre & Harrison, 2016). A critical approach to the analysis of the energy reveals the regional spatial inequalities associated with a social "energy

divide" (Bouzarovski & Herrero, 2017). Energy poverty is related to deprivation and vulnerability which is experienced by citizens being unable to meet their basic domestic and household energy needs. While analysing regional inequalities in EU member countries, Lithuania together with other post-Communist states of the CEE are described as countries with the highest energy poverty levels and vulnerability of citizens in the European Union.

## A New Pedagogy and Active Methods in Addressing Pedagogical Challenges and Overcoming Difficulties in Teaching Energy Geographies

Teaching energy geography is mentioned in the literature as a topic that poses a number of pedagogical challenges and difficulties (Huber, 2016). On the one hand, the subject itself is difficult due to the complexity of energy systems. Students experience a wide range of negative feelings: emotional distress, frustration, apathy, confusion, hostile defensiveness. Therefore, there is a need for effective pedagogical approaches when teaching energy geography. The search for new pedagogical approaches in energy geography is relevant to the whole subject of geography.

When discussing new trends, the need to include a new pedagogy, i.e., to build on the constructivist approach, when students construct knowledge in contexts that are meaningful to them, integrate active learning strategies, apply problem-based and inquiry-based learning, fieldwork and, at the same time, integrate new technologies in geography: digital data and imagery, new media, is emphasised (Day, 2012). On the one hand, referring to a cognitive constructivism approach, it is important to take into account the processes of constructing knowledge through accommodation and assimilation of new knowledge. Other forms of constructivism: social and pragmatic constructivism, where knowledge is constructed in interaction with other social actors (teachers, other students, community members) and in solving practical problems that are relevant to the learner, the community and society (a pragmatic approach), are also important. Although these new changes are discussed in the undergraduate teaching of physical geography, they are also important in school geography.

The constructivist approach emphasises the responsibility of learners for their learning, adjustment of learning to learners' backgrounds, skills and aspirations, collaboration among learners. Unlike passive learning, when students learn theory and learn from textbooks and examples, active learning, "learning by doing" as an inductive approach provides students with field

examples, case studies or problems and it embraces classroom assignments, fieldwork and laboratory measurements, group work and student self-assessment and peer teaching. While traditional learning methods (learning in the classroom, from textbooks) are important, the following learning strategies are very useful for applying active learning in geography: problem-based (PBL), inquiry-based (IBL), experiential and service-learning (SL) through community engagement, fieldwork when the "real world" environment outside the classroom becomes a learning resource (Day, 2012).

One more important strategy of the constructivist approach to facilitate learning energy geography is a context-based approach. This concept is applied broadly in science education when one can apply scientific knowledge to the personal, social and global problems they encounter as citizens, when students can confront socio-scientific issues and when learning is based on real-world problems with an emphasis on interdisciplinary connections, where applications of science provide starting points for developing scientific ideas (Dori et al., 2018). Thus, the content of learning should be related directly to some personal or social aspect of the students' lives and represent authentic relevant issues. Students learn about certain phenomena in a specific context which covers societal, industrial and ethical aspects, people's activities and life within a community or society (ibid). According to Gilbert (2006), a context is considered as reciprocity between concepts and applications and as the social circumstances. The author distinguished four attributes of an educational context: (a) a setting, a social, spatial and temporal framework within which mental encounters with focal events are situated; (b) a behavioural environment of the encounters, the way that the task(s), related to the focal event, have been addressed is used to frame the talk that then takes place; (c) the use of a specific language, as the talk associated with the focal event that takes place; (d) a relationship to extra-situational background knowledge. The context-based approach includes "situated learning" which creates a suitable physical, social and psychological environment (Gilbert et al., 2011).

Fieldwork acquires new significance when studying the environment and when learning activities are set up outside the classroom and held in the real world. The fieldwork creates an opportunity to put theory into context. This learning strategy allows combining constructivist learning (where knowledge is constructed in real-life settings) with elements of cognitive, affective and behaviour-based learning, and experiential learning by acting and reflecting on everyday experience. Van der Horst et al. (2016) describe the experience of building energy literacy by applying fieldwork through a combination of active learning, smart meter technologies and reflection. Students asses their

domestic energy use and consumption in "the field" – they monitor how electricity is used in their own homes. The fieldwork is mediated through the use of technology monitoring the consumption of electricity.

Day (2012) states that all these strategies of active learning lead to the development of various competencies: general skills, such as critical thinking, problem-solving, and subject-specific skills, such as spatial thinking, use of GIS (Geographic Information System), cartography and field methods. New approaches in teaching geography are related to IT (Information Technologies) integration: besides textbooks, electronic media and online materials, digital data, analysis software GIS and remote sensing data are increasingly used. At the same time, the role of Virtual Learning Environments (VLEs) is growing.

To overcome the learning difficulties of this subject, teachers seek to connect the everyday-ness of energy to both key concepts in geography and political questions outside the classroom (Huber, 2016). Additionally, the teaching of topics in energy geography involves the use of active methods and new pedagogy approaches applied in geography didactics.

Many energy geographers underline the general principles of constructivist and social justice perspectives in class on energy geography and highlight the use of active learning approaches in teaching, emphasising critical thinking, reflection and transformation as a pedagogical goal (Thoyre & Harrison, 2016). As noted above, energy geography belongs to a critical area of geography where development of critical thinking skills is essential. At the same time, active learning is important. Learning by doing in energy geography courses – where students complete a course-length project in active learning environments – increases student's motivation, opens the door for multiple learning styles, and enables linking theory with everyday life contexts. Through active experiential learning, students often link their experiences to the theory through reflection.

Thoyre and Harrison (2016) analyse the pedagogical experience of other authors in teaching energy geography and describe successful approaches and methods. Project-based learning activities seem to be a very promising pedagogical approach. The authors mention the work of Graybill (2016), which describes how university students are engaged in a semester-long video project on the topic of the Arctic and Urban Space. This pedagogical approach as a combination of energy geography and videography demonstrates good practice on how to employ digital technologies and digital storytelling in combination with time-intensive teamwork and work with new technologies and computer programs. According to Graybill (2016), this pedagogical practice has a dual purpose of encouraging students to become more critical consumers of knowledge production as well as providing them with a new way to create and

disseminate knowledge in their futures beyond the classroom. It is achieved by engaging with multimedia knowledge on energy geographies using videography (p. 56). This videographic teaching module is an example of how to engage students and build their energy geography knowledge and skills in multimedia with the purpose of expanding the geographic knowledge for academic and non-academic audiences.

Bodzin et al. (2013) described the effectiveness of a geospatial curriculum approach to promote energy literacy at the middle level in the science education curriculum. The use of geospatial technologies (GT) as a learning technology with the focus on the concept of spatial nature of energy resources contributes to the development of knowledge on the acquisition of renewable and non-renewable resources, energy generation, storage and transport, and energy consumption and conservation. Energy, scientific and environmental literacy could be promoted by carrying out geospatial analysis and employing reasoning skills with integrating GT. The authors (Bodzin et al., 2013) delineate how GT tools (geographic information systems (GIS), virtual globes, such as Google Earth, Global Positioning System, and other related technologies) allow processing geospatial data into visualisations to facilitate problem-solving in energy learning activities. The GT could be effectively used while analysing the map view geo-referenced data locations of sustainable and non-renewable energy resource materials, proposed new power plant locations, the existing transportation infrastructure and environmental characteristics of an area. The use the GT enables students to learn about making informed decisions concerning energy resources to choose and decisions to make for a country on the supply of electricity.

## Teaching About Nuclear Energy: Enhancing Energy Literacy and Scientific Literacy

Energy literacy is enhanced by energy education which is implemented in several school subjects: geography, physics, technologies and chemistry. Bartley et al. (2013) describe how energy is related to the building of multidimensional science literacy in the subject of physics. The development of these scientific and social competences is implemented through the integration of school subjects (including geography). The authors (Bartley et al., 2013) present a pedagogical scenario of lessons of physics on energy and discuss how learning about energy could be combined with building an understanding of how science and technologies influence society as well as with fostering citizenship skills. This case is an example of the development of multidimensional science literacy through

library research, classroom debates and reading, synthesising, and reflecting on articles in class. Students were encouraged to work collaboratively, formulate, analyse and interpret ideas and data, to perform logical reasoning, to gather evidence. At the beginning of the lesson, the teacher gives an introduction on basic understanding of energy concepts and initiates the discussion with students on different forms of energy, renewable and non-renewable energy, transformation and conservation of energy. The students are given texts for reading in class on different types of energy; they are invited to discuss the energy use in their country (the USA), the alternative, benefits and drawbacks to using other energy sources than the main source of energy (the oil). The students are invited to make library research on alternative energy resources and discuss the findings with other students. During the library research, the students learn about solar, wind, hydroelectric and nuclear energy. The students learn about the generating capacity of nuclear energy, the process of releasing nuclear energy from uranium, the nuclear fission, and the work of reactors and nuclear power plants.

Additionally, threats of nuclear energy to people and the environment are also exposed in the literature analysis. After the students carried out their research in the library, the teacher invites students to discuss the benefits and drawbacks to using each type of energy. The teacher gives students several resources on pro and con to the use of nuclear energy, the costs and benefits of nuclear energy.

Students read articles, discuss in groups the future of nuclear energy (majority of resources suggested by the teacher are devoted to the Fukushima disaster) and produce a poster. Later, students demonstrate their poster presentation in a poster gallery walk, discuss the future of nuclear energy and write a letter to a US Senator inviting to discourage the proliferation of nuclear energy. It is noteworthy that while developing scientific literacy the students improve their citizenship competences, literacy (writing skills) and general analytic skills, when students improve their ability to "examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content" (ibid).

## Energy Literacy and Energy Issues in the National Curriculum of Geography in Lithuania

In the present section, the authors, grounding on the conducted scientific overview of literature on energy and energy literacy, analyse whether the competences and content formulated in the national geography curriculum

**Tab. 1:** Areas of activity forming parts of the geography competency in different stages of education

| Basic education level (forms 6–10) | Secondary education level (forms 11–12) |
|---|---|
| Orientation in the area and map | Orientation in the area and map |
| Reading of geographical information | Analysis of natural and social processes |
| Cognition of a region | Geographical investigation |
| Cognition and investigation of environment | |

represent topics on energy (also including nuclear energy issues) and are directed to develop energy literacy. Major documents regulating the national curriculum in Lithuania, specifically Lithuanian General Programmes of Primary and Basic Education. Social Education (2008) and General Programmes of Secondary Education: Social Education (2010), were chosen for the analysis. The competences sought to be developed throughout the subject of geography were analysed as well as their relation to the topic of energy and energy literacy were dealt with.

The concept of specific areas of activity in the formal national curriculum would mean that these areas of activity can be treated as parts of the geography competency (Tab. 1):

Besides identification of the areas of activity, the national curriculum on geography presents recommendations for the content, i.e., related topics. It is worth noting that quite common and broad topics are listed (e.g. "Energy Industry" and "Global Economy"); therefore, later (in the stage of development of the curriculum) other developers of the curriculum (authors of textbooks, teachers preparing and selecting materials, designing education plans in schools) may put a more specific content into the frameworks of these broadly formulated topics (in our case of analysis, topics on energy). Such a broad naming and definition of the topics at the stage of implementation of the curriculum basically allow and create preconditions for the analysis of energy and energy industry as the most important branch of global and national economy, in-depth explore political economy, economic and energy geography where energy is a mediator in the human–environment relationship. Grounding on the concept of energy geography proposed by Calvert (2016, p. 104), the context of energy can be incorporated into many thematic areas, for instance, energy development, transport systems, market economy, consumption models and their impact on environment, consumption of natural resources, etc.

Seeking to reveal the theme of energy in the curriculum and to link it to the specific skills to be developed through it, the researchers revealed that the content of the competence and its levels were quite differently defined at different levels of the curriculum. The areas of activities are indicated in Lithuanian General Programmes (which later are divided into knowledge, skills and attitudes), what should be gained by school students learning geography; whereas topics linked to the mentioned parts of the geography competency are very broad and general. On the one hand, this allows teachers construct a particular content of their lessons which at that time seems relevant to them, by choosing materials from various sources (including media). Moreover, other means of implementation of the curriculum, school textbooks, provide materials which enable gaining skill set in the programmes. In this case, an assumption is drawn that quite extensive *presentation of the energy-related topic in the national curriculum creates preconditions* for development of energy literacy. Van der Horst et al. (2016) define energy literacy as abilities to make responsible decisions and take actions decreasing energy consumption at the personal (local) level; and, later on, this allows making energy-related decisions at the public (global) level, too. Grounding on the concept of energy literacy provided by DeWaters et al. (2013), geography curriculum allows perceiving the role of energy science and technologies at the national and global levels. It is underlined that the characteristics of energy literacy in the national curriculum are not specifically described and addressed.

To conduct the analysis of the evolution in the gaining of skills, the taxonomy by Bloom et al. ( 1956) and Anderson & Krathwohl (2001) defining the hierarchy of foreseen levels of learning skills has been employed This taxonomy was helpful in identifying how energy-related competencies of various complexity levels are introduced in different stages of education.

It is worth noting that DeWaters et al. (2013) pointed out the levels of energy literacy: cognitive, affective (attitudes, values) and behavioural (including predispositions to behave). The cognitive element embraces contents knowledge on energy and cognitive skills; the affective element implies positive energy-related attitudes, which would allow reducing environmental impacts related to energy consumption, economic responsibility for using renewable resources; and the behavioural element deals with energy-saving habits, energy consumption patterns.

When analysing the content of Lithuanian national geography education, the following questions were raised: is energy literacy sought to be developed? Are preconditions for application context-based approach in teaching about energy created and what contexts of energy consumption are defined by the

national geography curriculum? How do these contexts of energy consumption lead to development of energy literacy in school students?

In terms of the area of activity "**cognition of the regions**" defining the geographical competency to be developed, there is an emphasis on the abilities to gain knowledge on geographical conditions of Lithuanian and world's regions, specific characteristics of the spatial structure, phenomena and regularities of natural and social environment. In the case of programmes for forms 11–12, this competency is developed, which is completely natural, in comparison to lower forms; the content of it is broadened and it becomes more complex because the knowledge of social processes, besides knowledge on natural processes, is included in these higher stages of education. In such a way, the title of this area of activity for forms 11–12 is broadened and named "*Analysis of Natural and Social Processes*"; moreover, it indicates that these are the abilities to gain knowledge, analyse and assess geographical conditions of Lithuanian, European and world's regions, specific characteristics of their spatial structure, phenomena and regularities of natural and societal environment.

The analysis of energy-related topics reveals a tendency of the move from a broad, more common definition of the content towards more specific forming of the content of a topic in the programmes, for instance, titles of topics in programmes for forms 5–6 underline that students must characterise continents only in general terms; whereas in senior forms more specific topics, such as *characterisation of natural, economic features of specific regions and countries, characterisation of the reclaiming of natural resources* (7–8 kl.), are introduced, which means that students will be acquainted with natural resources, including energy, of particular regions and countries, characteristics of the economy of countries will be analysed, and significance of energy for the economy and economics is mentioned.

When dealing with the topics for forms 11–12 in relation to the *gaining of knowledge on regions* as the area of activity, the situation is different because the topics are not linked to the abilities singed out in lower forms; they are rather linked to the areas of geography as a subject (natural geography, geographical cognition, social geography, regional geography); nevertheless, specific titles are found as well: "Impact of Economic Activity on Natural Environment", "Major Indicators of Country's Economy", "Energy Industry", "Industry". On the one hand, these topics are quite common; however, they refer to specific contexts. In this case, it is likely that, for instance, when analysing the "Impact of Economic Activity on Natural Environment" in relation to the context of the energy investigated by us, students should learn what impact on present-day landscape is made by fossil fuel and electricity produced from it. Then, a

currently criticised and highly relevant context in the world, the $CO_2$ emission context, as a factor of global warming and climate change could emerge. Such approaches lead to the strategies of the decision-making mentioned by Van der Horst et al. (2016), such as renewable energy sources, other means of energy output (wind, sun, etc.), seeking to protect environment.

When analysing the area of activity "cognition of regions", the authors of the research found out that the abilities listed in the general programmes, according to development of skills in various stages of learning, from form to form (from form 5 through 12), are characteristic of a specific consistency in compliance with the levels of cognitive cognition (from knowledge to evaluation) formulated in the taxonomy designed by Bloom et al. (1956), Anderson & Krathwohl (2001).

It should be noted that within this area of activity the national geography curriculum does not reflect the level of application at all, which is underlined in scientific literature on energy literacy (Van der Horst et al., 2016); no statements linking to the level of application were found neither in formulated skills nor in titles of topics (Tab. 2).

Statements of the level of synthesis dominate (there are 8 of them), and slightly less are connected to the level of analysis (6). Relating to the theme of energy under investigation and development of energy literacy, an assumption that in the context of cognition of regions students should recognise and compare characteristics of regions in relation to energy resources, energy production, structure of economy, etc. can be drawn. However, the level of application of energy-related decisions is not reflected; therefore, a certain mismatch with the consistency in competence development is observed in this case, and there doubts on whether students are provided with opportunities to gain practical energy-related skills occur.

The analysis of the consistency in gaining the skills according to separate stages of education reveals that forms 5–6 emphasise the level of understanding because it is sufficient for students to define only several characteristic features of the continents. The description of students' skills in the framework of the national geography curriculum graduating from form 8 could be attributed to the levels of analysis and synthesis in compliance with the Bloom's taxonomy, since it is projected that students will be able to single out, compare characteristic features of separate regions. In this case, it is worth noting that the described skills were attributed to the higher level of synthesis because students learn about continents, separate regions, countries and diversity of their characteristic features exactly in this stage.

**Tab. 2:** Consistency in the gaining of skills and interaction of topics characterising the activity of "Cognition of Regions" in general programmes

| **Levels of** | **Forms 5–6** | | **Forms 7–8** | | **Forms 9–10** | | **Forms 11–12** | |
|---|---|---|---|---|---|---|---|---|
| **cognitive skills** | Skill | Topics | Skill | Topics | Skill | Topics | Skill | Topics |
| Evaluation | | | | **1** | | **1** | | **1** |
| Synthesis | | | **2** | **1** | **2** | **1** | **1** | **1** |
| Analysis | | | **1** | **1** | **1** | **2** | **1** | |
| Application | | | | | | | | |
| Comprehension | **1** | **1** | | **2** | | | | |
| Knowledge | **1** | | **1** | | **1** | | | |

At graduation from form 10, similarly to form 9, the level of synthesis prevails (Tab. 2), since students must be able to substantiate similarities and differences of separate regions. Moreover, description of the assessment stage can be found in formulation of the topics "Find out and assess the most important political and economic alliances". In the case of forms 11–12, formulations attributed to higher levels, i.e., synthesis, analysis and assessment, dominate (Tab. 2); students achieve the highest level of cognitive skills formulated by Bloom et al. (1956) because they must be able to point out and assess characteristics and features of different regions; and, in relation to the theme of energy, the equivalents reflecting the said in the statements found in formulations of skills and topics were sought for.

To sum up, the gaining of the skills defining the activity of *cognition of regions* is characteristic of consistency because formulation of skills and topics become more complex in compliance with the stages of learning. However, the level of application is not fulfilled throughout the entire period of learning.

The theme of energy and energy literacy is not mentioned in the wording of the skills; nevertheless, the formulations of skills, such as *cognition of geographical conditions in Lithuania and the world*, *phenomena and regularities of natural and social environment*, *geographical conditions*, etc., allow integrating topics on energy resources, energy economy and economy, as well as developing energy literacy at the stage of implementation of the curriculum.

When analysing the area of activity "reading of geographical information", the researchers found out that it was defined by the following skills: reading, analysis, perception, critical assessment and interpretation of sources of geographical information, rendering of geographical information in written, visual and audial forms. It should be noted that this area is named only at the level of

basic education (forms 5–10). Consistency in the gaining of skills in this area is quite interesting because major "load" is allocated to the topics formulated in the programmes for forms 9–10 (Tab. 3), where 15 topics relate to the context of energy. Formulation of topics reflecting the theme of energy covers almost all taxonomy levels, except for knowledge.

However, when comparing the interactions of topics and skills named in the programmes, it is observed that there are less skills formulated in this stage of learning, 4; and all these are linked to higher levels – synthesis and assessment (Tab. 3). When reading the programme for forms 9–10 and relating it not only to the theme of energy, it was observed that there were many topics; therefore, questions on whether such structure of the curriculum allowed achieving the anticipated levels of skills arose.

In general, when dealing with the common consistency in the gaining of skills related to the activity "reading of geographical information", it was observed that the levels of knowledge and application were reflected the least (Tab. 3), the levels of understanding (9 statements) and synthesis (11 statements) were reflected the most, which shows insufficiency of the development of application skills.

When analysing how the skills of reading geographical information are defined in the national curriculum, referring to the taxonomy levels formulated by Bloom et al. (1956) in separate stages of learning according to forms, the authors of the research point out that in this case the beginning is the level of knowledge which is recognised in the phrasing of topics; and, in relation to the development of the skill, there is a transition to the levels of comprehension and application because students graduating from form 6 must be able to recognise, use sources and information available in them. When relating to the context of energy, it could be foreseen that students will properly comprehend information on energy which is presented in various contexts or will be able to choose required texts and information available in them. Referring to the definition of energy literacy introduced by DeWaters et al. (2013), it should be understood as perception of the energy science and technologies as well as the role of their distribution at the national and global levels, how students gain knowledge on the content of energy.

The national curriculum of geography foresees that students at graduation from form 8 achieve the levels of analysis and synthesis. However, it was observed that at this stage of learning any topic related to energy (Tab. 3) could not be pointed out. It foresees that students must be able to select sources, to properly use and compare them, to analyse phenomena and processes while grounding on them and to properly generalise and render information. It is

likely that when realising these objectives at the level of implementation of the curriculum (which would be a decision of the authors of textbooks or a teacher himself/herself), students could compare information on energy presented in different sources. In such case, this would be an element of energy literacy, as pointed out by DeWaters et al. (2013), the definition of dimensions which is again only information on energy selected and systematised by students.

The level of basic education ends with achieving the highest level of cognitive knowledge, assessment and evaluation, because here it defines that students should be able to select trustworthy sources and analyse, assess and render a situation of natural, social, economic and political phenomena in various regions grounding on them. It is likely that during the processes of learning students will be able to assess the influence of various energy-related contexts on different regions and their economy or development of economy. Assessment of reliability of information is treated by various authors as a feature to be developed.

When analysing topics which are formed in general programmes, the authors of the research reveal that the skills of reading geographical information are gained when following certain consistency: from a specific context, e.g. "Natural Resources and Consumption of Them", to a quite broad and complex one, such as "Dependence of People's Economic Activities on Historical (Formation of Civilisations) and Natural (Water, Climate, Minerals, Soil, Relief) Conditions of Environment", which also complies with the development of skills according to Bloom's taxonomy of cognitive skills, even though, as mentioned earlier, there is lack of consistency (Tab. 3).

Relating to the context of energy under analysis, the description of the national curriculum includes specific statements or groups of statements to be

**Tab. 3:** Consistency in the gaining of skills and interaction of topics characterising the activity of "reading of geographical information" in general programmes

| **Levels of cognitive** | **Forms 5–6** | | **Forms 7–8** | | **Forms 9–10** | |
|---|---|---|---|---|---|---|
| **Skills** | Skill | Topics | Skill | Topics | Skill | Topics |
| Evaluation | | | | | **1** | **2** |
| Synthesis | | | **3** | | **3** | **5** |
| Analysis | | | **2** | **2** | | **2** |
| Application | **1** | | | | | **2** |
| Comprehension | **1** | **1** | | **2** | | **4** |
| Knowledge | | **1** | | | | |

related to energy, sources of energy, and influence of energy on environment or people's lives. In this case, it can be anticipated that the above mentioned levels of energy literacy pointed out by DeWaters et al. (2013), cognitive, affective and behavioural, will be recognised, since diversity of topics and the skills listed in the programmes are related to all taxonomy levels.

In lower forms (forms 5–6), topics "People's Activities" and "Natural Resources and Consumption of Them" are suggested; they would meet the theme of energy. As observed, they do not name the theme of energy; nevertheless, it is likely that, within the topic "People's Activities", a more specific topic could be projected: introduction of economy activities of residents, which would cover the concept of energy economy, too. The second topic is more concrete: "Natural Resources and Consumption of Them"; its formulation clearly supposes that it projects introduction of natural resources, including energy.

In this context, it can be related to the cognitive level of energy literacy, as pointed out by DeWaters et al. (2013), because students gain specific knowledge on energy resources, reclaiming of them, production and consumption of energy.

There are five topics related to the context of energy found in forms 7–8, including two topics related to natural resources ("Urbanisation of Territories Depending on Natural (Relief, Climate, Soils), Economic (Natural Resources, Location of Industry), Social Conditions" and "Opportunities for Using Natural Resources (Renewable and Non-renewable Resources)"; three topics are related to economic activities of people ("Geography of Economy", "Dependence of People's Economic Activities on Historical (Formation of Civilisations) and Natural (Water, Climate, Minerals, Soil, Relief) Conditions of Environment", "Major Parts of the Global Economy Structure (Bioproduction Economy, Industry and Services)". From the point of view of definition of the dimensions of energy literacy (DeWaters et al., 2013), such phrasing of topics would cover the cognitive and affective levels because students gain and deepen knowledge on energy, energy economy and find out the dependence of people's economic activities on conditions of natural environment. In its turn, this supposes particular formation of attitudes and values because elements protecting environment should be identified and analysed.

In the scope of programmes for forms 9–10, even 15 topics which could be related to the context of energy were singled out. It is interesting to note that at this stage of education only one topic, as indicated in forms 7–8, should deal with natural resources and sustainable consumption of them ("Rational Consumption of Natural Resources and Importance of Protection of Biological Diversity"), whereas all other topics are related to the concept of economy and economics,

and only one of them clearly indicates the topic of energy ("The Most Important Branches of Economy (*Fuel and Energy*, Metallurgy, Production of Machinery, Chemistry, etc.) and the Regions of Their Distribution in the World"); in cases of all others, the theme of energy is seemingly "hidden". Nevertheless, it can be considered that the theme of energy may be integrated, for instance, in the topic "Influence of People's Economic Activities (and What) on [Natural] Change", could project a theme on how the industry of economy changes nature; within the topic "Global Economy" and "Scheme of Production Links of Economy Branches", "The Most Important Provided Services – Production and Non-production (Social)" may project the theme of what place is taken by energy in the global economy structure and what are its relations to other branches of economy; in the topic "Situation of Lithuania in the Common System of Global Economy" one may recognise a likely projected theme of how this situation is determined by the economy sector; the topic "Economy Resources in Lithuania and the World (Natural: Flora, Fauna, Water, Earth – Its Surface and Depth; Man-Made: Work, Finances, Information, Capital)" implies a smaller topic of what energy resources created by man are; the topic "Influence of Industry on Environment (Pollution, Changing of Landscape)" has a smaller topic on what kind of effect is made on environment by mining of natural energy resources and production of energy.

When relating topics for forms 9–10 to manifestation of the dimensions of energy literacy (DeWaters et al., 2013), it can be stated that the abundance and diversity of topics presented in the general programmes completely reflect all three levels of energy literacy: cognitive, affective and behavioural. For instance, students already get acquainted with energy as a branch of industry – the concept is introduced (cognitive level); a topic on the influence of people's economic activities on environment (influence of energy industry on environment can be analysed in this case) – would meet the affective level because it leads to the formation of positive attitudes; and a topic "Influence of Industry on Environment (Pollution, Changing of Landscape)" should already clearly allow forming habits, models of energy consumption, which is related to the behavioural level (according to DeWaters et al., 2013).

To sum up the situation of gaining the skills related to the activity of *reading of geographical information* and linking it to the development of energy literacy in general programmes, it can be stated that the systematic approach is applied in the national formal curriculum, since, first of all, it recognised that students must obtain sufficiently consistent information on energy, its sources. Formulation of the skills-to-be-gained is quite consistent, encompasses higher levels of thinking, and the thematic development of the energy theme proceeds

from specific topics to factual material moving towards a broader and deeper context. Linking to the concept of energy literacy, as defined by DeWaters et al. (2013), it is observed that the formal curriculum foresees development of competences in consistency because when starting from lower forms (forms 5–6) the cognitive dimension prevails; later, the cognitive dimension intertwines with the affective one; and in forms 9–10 all three dimensions (cognitive–affective–behavioural) are recognised. It can be stated that in the national educational content the characteristics of the activity of reading geographical information reveals preconditions to form skills of energy literacy.

The activity area "orientation in the area and map" at the stage of basic education (forms 5–10) is defined as skills to orient oneself in a geographical area, plans and maps of a location, to understand the objects existing in them; whereas the skills for secondary education (forms 11–12) are orientation in a diverse geographical area (local, regional and global) and cartographic drawings, to understand the objects situated there.

Having analysed the skills and consistency in gaining them in the activity of *orientation in the area and map*, a particular controversy is observed in this case, since basically throughout the entire period of learning, from forms 5 through 12, formulations of the skills in the area encompass a prevailing level of application; the transition from this level to one higher level, that of analysis is found (Tab. 4).

The topic "Maps and Plan" and learning how to use them dominate throughout the entire period of learning. This situation is illustrated by the statements underlining that students, after graduating from form 6, must be able to distinguish a plan from a map, to be able to orient in a specific location; when graduating from form 8, students must be able to use plans and maps to orient in a local or global area. Perhaps, the context slightly broadens by introducing a global and a local area; however, the emphasis on the use of plans and map remains. After graduation from form 10, the emphasis on the use of plans and maps remains, only with added one more contextual element, i.e. characterisation of natural, economic and political geographical position of objects, which in the terms of activity can be attributed to the level of comprehension because, in the aspect of complexity, students do not do anything new, only the content is supplemented. In form 12, the definition of the competency of orientation in the area and map is supplemented with the necessity for students to be able to find relations among objects in various geographical sites (local, regional, global).

The researchers draw an assumption that such approaches for formulation of the skills of "orientation in the area and map" may partly comply with the

**Tab. 4:** Consistency in the gaining of skills and interaction of topics characterising the activity of "orientation in the area and map" in general programmes

| **Levels of** | **Forms 5–6** | | **Forms 7–8** | | **Forms 9–10** | | **Forms 11–12** | |
|---|---|---|---|---|---|---|---|---|
| **cognitive skills** | Skill | Topics | Skill | Topics | Skill | Topics | Skill | Topics |
| Evaluation | | | | | | | | |
| Synthesis | | | | | | | | |
| Analysis | | | **1** | | **1** | | **1** | **1** |
| Application | **2** | **2** | **2** | **1** | **2** | **2** | **1** | |
| Comprehension | | | | | | | | |
| Knowledge | | **1** | | | | | | |

concept of energy geography introduced by Calvert (2016, p. 104) who has it that this is teaching on energy development, transmission, markets, consumption models and their impact on area, region or prospects of resource management. And, as Calvert (2016) adds to it, energy geography encompasses the following tasks: development of energy supply chains, identification of sites and models where investment proceeds; assessment of equipment risks on economy and environment, especially in the context of nuclear energy development; perception of how energy technologies develop among countries; and comprehension of a map, how energy is consumed in different regions and countries (production, trade etc.) (Calvert, 2016). Thus, in this case, activity of orientation in area and map grounding on the concept of energy geography can be perceived in a way so that the use of a map in processes of learning can and must lead to perception of a complex concept of energy, when not only recognition of objects depicted on a map takes place but, on the contrary, construction of maps according to various parameters (e.g. prediction of possibilities for various models in different locations and regions) which would allow students perceive energy as a complex phenomenon takes place.

Summing up, from the point of view of the definition of the competence of orientation in the area and map, it is obvious that the dominating emphasis is laid on the reading of maps and plans, finding of objects in them and revealing of their interrelations. It should be noted that, in relation to the context of energy throughout the entire period of delivery of the geography as a subject from form 5 through 12, the taxonomy levels of synthesis and assessment are not covered at all.

Then, it becomes interesting which topics lead to achieving this and how this can be linked to a chosen theme of energy. In general, in form 12, at graduation

from school, students achieve the analytical level of orienting in the area and map at least.

Thus, to sum up, consistency of the gaining of skills characterising the area of activity *orientation in the area and map* in Lithuanian general education programmes is not at its strongest, since the relation of these skills to higher levels of thinking raise doubts. Nevertheless, the authors had some doubts about whether the analytical level is really achieved at least or it remains at the level of application only. If we compare with a tendency that there were not many topics related to energy and activities of orientation in the area and maps (in comparison to topics covering other competences), there are only 15 topics in total in forms from 5 through 10. As it was mentioned, a major theme from form 5 through 12 focuses on maps and their diversity, explanation of the structure of a map. The authors did not find any direct relation to energy in the programmes; nevertheless, there is a topic in the programme for forms 9–10 which could be named as "identification of natural, economic and political geographical position of objects", and it is likely that, when analysing the content and structure of maps, energy objects will also be recognised: distribution of energy resources, energy enterprises, etc. In programmes for forms 11–12, this theme is slightly extended by emphasising that specific areas of cognition will be explained while orienting in map: environment, territory, region and world, which basically "brings down" to the level of comprehension and raises doubts whether this is true.

Having revealed the topics at the energy literacy levels defined by DeWaters et al. (2013), it becomes clear that in this case the focus is only on the cognitive level because these topics pointed out, e.g., energy resources and their distribution (forms 11–12), very clearly allow understanding that students will gain the content of specific knowledge on energy resources. If assessed as a stage of secondary education, it would be too low to achieve this cognitive level only. However, when relating it to the definition of energy geography, as introduced by Calvert (2016), perhaps an assumption could be drawn that such format of presentation of skills and topics exactly allows forming a specific perception of energy; therefore, in this case, the analysis of teaching materials proves it is necessary.

The skills defining the area of activity **"cognition and investigation of environment"** at the stage of the forms 6–10 are presented as skills to carry out geographical observation and investigation of environment, to formulate hypotheses, collect data, conduct various measurements and calculations, search for solution ways, draw conclusions and assess obtained results. In forms 11–12, the name of the area of activity is made slightly more specific,

"**geographical investigations"**, and the skills named at the lower stage are extended by adding application of methods for cognition of geographical area and theoretical-practical modelling of situations.

Assessment of consistency of the stages of competences in terms of the Bloom's taxonomy reveals specific regression of skills (Tab. 5). If in basic education proceeding from form 5 through 10 the gaining of skills is characteristic of specific consistency, starting with skills of comprehension in form 5 and ending with evaluation in form 10, then at the stage of forms 11–12, it seems, there is regression because formulation of the skills reveal the levels of application and analysis (Tab. 5); and comparison of the topics revealed that the disclosing of the energy-related content would proceed at the levels of comprehension and analysis (skipping application).

The research reveals that formulation of the research competence is the most poorly expressed in the formal curriculum. What is the proof of it? First, skills of investigation should relate to higher levels of thinking – analysis, synthesis, assessment; however, while observing the formulation of skills or topics helping gain them within the programmes it was observed that, for instance, skills corresponding to the level of synthesis and assessment are named only in the programme for forms 9–10 (synthesis: "to render obtained results to others in various forms", evaluation: "to explain advantages and disadvantages of the conducted investigation, to feel responsibility for the results of the work carried out"). The formulation of these skills is not related to the subject of geography or a particular context under analysis; these are more statements naming general processes of investigation: rendering of results, explanation of the research results; or definition of value attitudes: demonstration of the sense of responsibility. These general skills do not reflect any specific (related to the subject of geography) content of investigation.

Perhaps, there could be a logical explanation to it: the gaining of the competence of cognition and investigation of the environment is defined at the taxonomy level of application because research is basically a practical work; however, there is lack of skills forming higher-level thinking.

Searching for connections between formulated skills to be gained and energy, it is observed that the theme of investigation is defined quite broadly, and it encompasses and could basically cover the theme of energy, too. Major topics which may relate to energy are the dominant economic aspects, e.g., "students are taught how to carry out investigation (e.g. maps; climatic zone and type; inland waters; states according to social economic indicators) and to write a result of it" (forms 7–8), "using sources of geographical information, students learn to carry out natural, social and economic investigations, to solve

**Tab. 5:** Consistency in the gaining of skills and interaction of topics characterising the activity of "cognition and investigation of environment" in general programmes

| **Levels of** | **Forms 5–6** | | **Forms 7–8** | | **Forms 9–10** | | **Forms 11–12** | |
|---|---|---|---|---|---|---|---|---|
| **cognitive skills** | Skill | Topics | Skill | Topics | Skill | Topics | Skill | Topics |
| Evaluation | | | | | **1** | | | |
| Synthesis | | | | | **1** | | | |
| Analysis | | **1** | | **1** | **1** | | **1** | **1** |
| Application | **1** | **1** | **2** | **1** | **2** | **3** | **1** | |
| Comprehension | **1** | **1** | | | | **1** | | **2** |
| Knowledge | | | | | | | | |

problems, draw conclusions" (forms 9–10); "to characterise world's regional and specific principles (historical, natural, social, economic, political)" (forms 11–12). These examples demonstrate how investigation linked to energy could or should be oriented to quite a broad context: revealing of natural, social, economic aspects. The emphasis on the economic aspect within the energy literacy would enable, for instance, carrying out research on energy consumption in various countries and on its impact on economy etc.; however, on the other hand, if the economic aspect was dealt with only, this would narrow down the revealing of the concept of energy, since the context of energy, if assessed from the point of view of energy literacy, focuses on a much broader scope: includes energy production, environmental protection, spheres of social relations, geopolitics, geoeconomics, etc. If such specificity of revealing topics was followed, this would allow substantiating the revealing geography through its role for the future and survival, as proposed by Butt (2011) and Lambert (2013) investigating it as the geography like "a world subject", "curriculum of survival" and the "curriculum of the future". In this case, analysing the topics singled out in the formal national curriculum, the authors draw assumptions that, within the process of learning (at the stage of implementation of the curriculum), the concept of the nature of globalisation, how globalisation proceeds and what challenges and problems it creates should be emphasised. The context of energy could be analysed as the most important resource of economy, and, at the same time, reveal and investigate the industry of energy as the most important branch of global and national economy. In such a way, a necessity to analyse political economy and economy geography arises.

It should be noted that the wording of themes in the national formal curriculum is quite broad, and this creates some flexibility and an opportunity to

integrate various topics, since a teacher has got sufficient freedom to put specific content into broader topics, e.g., the programme for the forms 7–8 includes the formulated topic where "students are taught to search for connections among constituent parts of the natural and social environment, to identify regional differences of them, to explain what causes determine these differences, to draw conclusions"; allows a teacher choose any context for the research work, for instance, branches of industry, and, referring to them, project the process of teaching and learning. Then, in relation to the dimensions of energy literacy (DeWaters et al., 2013), the processes of learning could link to the behavioural level, when habits of specific energy consumption and saving, models of energy consumption, etc. are being developed; implementation of the opportunities is plausible in compliance with formulation of the topics.

To sum up all skills and topics named in the national curriculum that could be related to the theme of energy and to that of how the formulation of competencies comply with the taxonomy levels pointed out by Bloom et al. (1956) and Anderson & Krathwohl (2001) it was found that in a chosen theme and areas of activities (reading of geographical information, cognition of regions, orientation in the area and map, cognition and investigation of environment) the taxonomy level of application prevailed. Nevertheless, the striving to single out and formulate higher levels, i.e., those of analysis and synthesis, is observed. Therefore, assumptions can be drawn that, in terms of description of the national curriculum, the theme of energy has potential and opportunity to be introduced and revealed within the stage of implementation of the curriculum.

If analysed in terms of separate stages of learning (from form 5 through 12), the theme of energy would be rendered the most consistently and appropriately in terms of topics in forms 7–8 and 9–10. When exploring how basic skills-to-be-developed in the educational content are formulated, a tendency that even though energy literacy is not named, still preconditions for the development of the dimensions of energy literacy (cognitive, affective and behavioural (DeWaters et al., 2013)) are created, is revealed. A systematic approach is observed in the description of the national curriculum, which enables forming skills in a chosen area because consistent transition from concrete gaining of the content of knowledge to formation of attitudes and behaviour is observed. However, seeking to completely reveal how energy literacy is developed through the school curriculum, not only national formal curriculum but also the stage of implementation of that curriculum, i.e., teaching materials, textbooks, survey of teachers and deeper investigation of the process of learning, should be analysed.

Even though the development of energy literacy in the content of Lithuanian education is not presented or specifically defined, still the description of the national curriculum renders a broad general characterisation of the theme and competencies which allow teachers choose and formulate specific topics which can be related to relevant issues, including energy.

## The Concept of Nuclear Energy in Lithuanian Textbooks on Geography

The analysis of texts on nuclear energy in the textbooks seeks to identify the connection of textbook materials on nuclear energy to geographical skills and competences pointed out in comprehensive programmes and how it combines with the taxonomy levels of competences. Moreover, analysis of textbooks grounds on the concept of energy literacy and aims at finding out how the theme of nuclear energy reveals the aims of energy literacy, which, according to Flower (1976, cit. DeWaters et al. (2013)), encompasses the ability to make decisions at an individual and societal levels. In this case, it evaluates how the presentation of the nuclear energy concept in textbooks forms students' knowledge and attitudes about significance, role and impact of this type of energy at global, local and personal levels.

Referring to the energy literacy concept, school students should be able to assess significance of nuclear energy and its impact on their personal lives, living in immediate environment and global world. In such a case, grounding on statements of Van der Horst et al. (2016), characterising an energy-literate citizen, the concept of nuclear energy in geography curriculum and textbooks must be related to the goal to develop skills of decision-making at personal, regional, nationa and, global levels, which would mean that school students should gain knowledge on the impact of nuclear energy and could assess it as well as search for various decisions connected to consumption/non-consumption at various levels and in various contexts of social life. The conducted analysis of texts on nuclear energy in geography textbooks refers to the concept underlying energy development, transportation, markets or use patterns and their determinants from a spatial, regional or resource management perspective (Calvert, 2016, p. 104). Energy geography conceptualises energy as a social relation, and the energy mediates human–environment relationship. Authors investigating energy geography (Solomon et al., 2004; Calvert, 2016) single out the themes which are important to this branch of geography: monitoring energy supply-chain developments; identifying place-based factors which explained observed spatial patterns of energy-sector investment; assessing environmental and

economic risk, especially in the context of large scale nuclear energy development; understanding how energy technology diffuses within and between nations; and mapping regional variations in energy production, distribution and use.

Grounding on the levels of the competence development taxonomy singled out by Bloom et al. ( 1956) and Anderson & Krathwohl (2001), the researchers raise a question how nuclear energy is introduced in textbooks: is this phenomenon presented as complicated and complex?

The following questions are formulated to investigate textbooks on geography:

1) What is the structure of materials within the textbooks: content, volume of texts on nuclear energy and how this content relates to the geographical skills formulated in comprehensive programmes?
2) How does the presentation of nuclear energy in geography textbooks provide preconditions for development of energy literacy?
3) How do complication and complexity of the materials rendered in textbook texts combine with the taxonomy levels of geography competences pointed out in the national curriculum?

After carrying out analysis of 32 Lithuanian geography textbooks for forms 6–12 (Bačkienė, Pundienė, Januškis, 2009a; Bačkienė, Pundienė, Januškis, 2009b; Česnavičius & Gerulaitis, 2008/2007; Česnavičius et al., 2010/2008; Česnavičius, &Valančienė, 2008; Dijokienė, 2016; Gerulaitis, et al., 2010a; Gerulaitis et al. 2010b; Kynė et al., 2008a; Kynė et al. 2008b; Kynė et al., 2016; Kynė et al., 2015; Šalna et al., 2012a; Šalna et al., 2012b; Šalna et al., 2006; Šalna et al., 2009/2005a; Šalna et al., 2009/2005b; Šalna et al., 2014; Šalna & Sapožnikovas, 2010/2006a; Šalna & Sapožnikovas, 2010/2006b; Šalna et al., 2005a; Šalna et al., 2005b; Šalna et al., 2010a; Šalna, et al. 2010b; Šalna et al., 2010c; Šalna et al., 2012; Šalna &Tuskenienė, 2009a; Šalna & Tuskenienė, 2009b; Valančienė & Česnavičius, 2008; Valančienė & Dijokienė, 2007; Varanavičienė et al., 2017) the energy-related concepts and their illustration with examples have been found: energy resources, renewable and non-renewable resources, energy economy, and social and environmental aspects of the use of energy sources and energy production.

**The concept of nuclear energy in forms 7–9.** The analysis of the concept of nuclear energy was being consistently conducted starting from textbooks for form 7. The materials on the aspect under the interest of the researchers were not found in the texts of textbooks for form 6. Two textbooks by Šalna et al. (2009/2005a; 2009/2005b) for form 7 and two textbooks by Šalna and Sapožnikovas (2010/2006a, 2010/2006b) for form 8 have been analysed.

In the first instance, it was discovered that textbooks for forms 7 and 8 present materials related to nuclear energy in a way that there are dominant two areas in development of geography-related skills mentioned in the national curriculum: cognition of regions and reading of geographical information. The competence of map reading is slightly developed. Areas of different competences (acquaintance with regions, reading of geographic information, understanding of maps) intertwine because texts giving information on nuclear energy describe regions and countries of the world. Geography textbooks for form 7 introduce the following regions: Africa, Australia, Oceania, the Antarctic, South America and North America (Šalna et al., 2009/2005a.); whereas these are for form 8: Europe (Šalna & Sapožnikovas, 2010/2006a), East Europe and Russia, Asia (Šalna & Sapožnikovas, 2010/2006b), and single countries. Textbooks for form 7 include maps demonstrating sites of uranium mining in the Republic of South Africa (Šalna et al., 2009/2005a, p. 161) and Canada (Šalna et al., 2009/2005a, p. 241). Tables indicate and compare the volumes of uranium mining in various countries. For instance, Australia whose uranium mining constitutes 14 per cent, is mentioned as a country taking the second place in uranium mining in the world (Šalna et al., 2009/2005b, p. 180). However, there are no texts providing details about uranium as fossil fuel used in nuclear power plants; accordingly, such material does not substantiate introduction of these regions for students as sites where uranium is being mined (Republic of South Africa, Australia and Canada), no connections with nuclear energy. In discussion of regions and countries, the textbooks render numerical information, diagrams, indexes on the amounts of uranium mining and compares them in terms of different regions of the world. Nevertheless, our research reveals that texts of textbooks for form 7 introduce nuclear energy quite fragmentarily, which prevents from forming a generalised and whole concept for the students.

Thus, materials of textbooks for form 7 are not characteristic of a highly complex level in presenting energy; nuclear energy is presented indirectly (when talking about uranium). When comparing to the object of energy geography described by scholars (Solomon et al., 2004; Calvert, 2016), it can be stated that textbooks for this form lack a broader and consistent image of the energy sector y in relation to social, economic and political aspects of nuclear fuel mining in the discussed countries and regions. After the assessment of introduction of nuclear energy in textbooks for form 7, grounding on the concept of energy literacy, it was observed that the level of neither regional nor local energy consumption was presented: information on other regions of the world without any relation to the context of Lithuania is presented to students.

Texts for form 8 display more materials related to nuclear energy; and specific efforts to reveal characteristics of regions are observed. An explanation of pitchblende (uranic ore) as fossil which is "the most important fuel for nuclear power plants" (Šalna & Sapožnikovas, 2010/2006a) is already presented for form 8, which allows the students, differently from those of form 7, understand that "uranium" is linked to nuclear energy.

Another aspect to be related to nuclear energy in form 8 deals with the varieties of electricity production: water, thermal, renewable resources and nuclear. This information allows school students understand the diversity of energy sources and energy production industry. Specific aspects of nuclear energy discussed in textbooks for form 8 are linked to getting cognition of regions or countries, e.g., France is characterised as "having no large pools of oil or gas, though being famous for pitchblende (uranic ore) mining for many years. <. . .>. Currently, the country runs more than 20 such (nuclear, authors' note) power plants. They produce approximately three quarters of the entire electric power." (Šalna & Sapožnikovas, 2010/2006a, p. 84). The progress of Indian industry is connected to the development of nuclear energy: "Presently, India is rapidly developing high technologies. Nuclear power plants are being constructed all across the country." (Šalna & Sapožnikovas, 2010/2006b, p. 208). Comparing significance of natural resources in North Europe, the diagrams demonstrate different amounts of electric power produced in nuclear power plants in different countries: "In Sweden the amount is 43 per cent, in Finland it is 30.4 per cent, in Lithuania it is 77.7 per cent." (Šalna & Sapožnikovas, 2010/2006a, p. 66).

The information on nuclear power allows students start forming their understanding of energy-related regions, start understanding the spatial patterns of the energy sector, when the sector of energy comprises several different sources of energy, and nuclear energy constitutes an important part of national economies. Textbooks for the 8th form point out the countries that develop nuclear energy. These include Lithuania, too. Texts of the textbook comply with the strategic concepts of nuclear energy of the period they were written (in 2006). However, in relation to present-day global and Lithuanian strategies for energy development, these materials of the textbooks are already outdated and should be treated as historical, i.e., as a description of what was happening in the country many years ago. Seeking to fill in geography lessons with relevant content, a teacher should be assisted with materials that discuss contemporary priorities in the energy sector, for instance, the Lithuanian National Energy Independence Strategy (Lietuvos Nacionalinė energetinės nepriklausomybės strategija, 2018), which reflects the situation of state's energy sector 10 years

after the closure of the nuclear power plant and underlines the development of renewable energy sources, green energy.

Over the latter 10 years, the Lithuanian energy map and strategic perception of the development of energy industry have significantly changed. Energy is no longer being produced from nuclear energy since 2009; production of biofuel, biomass and biogas as well as wind, solar and geothermal energy is being actively developed. The development of the energy sector is being carried out through the decentralisation and demonopolisation of energy production, involving residents in the sector of energy economy, installing solar panel batteries and producing geothermal energy for house heating. Emphasis on these new energy-focused priorities could contribute to the development of the energy literacy, as named by Van der Horst et al. (2016), through civic participation and entrepreneurship, when connections to both local (national, Lithuanian) and individual (electricity production in household) contexts are clear.

The most pronounced instance of acquaintance with the region and connection to the nuclear energy is presented in form 8, when Ukraine is characterised and presented through the narration about the disaster at the Chernobyl Nuclear Power Plant. The textbook includes a separate chapter "Disaster of the Chernobyl Power Plant" (Šalna & Sapožnikovas, 2010/2006b, p. 148). This chapter comprises 4 short texts about the catastrophe, its causes and consequences: "In April 1986, the world was struck by the disaster of the Chernobyl Nuclear Power Plant. Caused by severe mistakes made while conducting experiments, several explosions took place in one of the reactors; the explosions damaged the roof made of steel and concrete mass weighing 1,000 tons and breached it. Few times more radioactive substances spread in the atmosphere than in 1945, when nuclear bombs had been thrown on Hiroshima and Nagasaki." (Šalna & Sapožnikovas, 2010/2006b, p. 148). The extent of the disaster is discussed: the increase of radiation in Ukraine, Belarus, Lithuania, Germany, Switzerland, France, Italy and Nordic countries as well as concern about safety; the consequences of the disaster: and pollution of large areas with radioactive substances, impact on nature and diseases caused by radiation (Šalna & Sapožnikovas, 2010/2006b).

Moreover, the text includes 3 maps depicting the spread of radioactive clouds 2, 5 and 10 days after the disaster (Šalna & Sapožnikovas, 2010/2006b, p. 148) and a map demonstrating the spread of radioactivity on the territories of Ukraine, Belarus, Russia and Lithuania (Šalna & Sapožnikovas, 2010/2006b, p. 149). The text is illustrated with photos: the view of the nuclear power plant after the accident, desolated and neglected houses and other buildings on the site of the catastrophe, a photo of a child with disability who was born

in the zone of radiation. Even though not extensive, such presentation makes quite an impact: various materials, i.e., texts, photos, maps, were used to create this narrative. The topic develops energy literacy in connection to important competences within the geography curriculum: cognition of a particular region and map reading.

The presentation of the Chernobyl-related topic extends the concept of energy in general and nuclear energy in particular, while energy is described not only as an economy part of particular regions, but also an important source of economy operation and development. The analysis of disasters in nuclear industry is a separate topic which reveals potential insecurity of nuclear energy, its harm and threat to people, nature and environment. Here, not economic but rather environmental aspects of energy use and production are disclosed. It should be noted that scientific literature and political discourse discuss the Chernobyl disaster as a turn in the entire history of the nuclear energy industry. The accident demonstrated a gigantic danger of the use of nuclear energy, changed the entire history and direction of this branch of economy. This has become the largest trigger of the anti-nuclear movement throughout the world. Since the start of the nuclear energy industry (since the 1950s of the twentieth century), it had a bright future predicted to it, and many expectations were linked to this type of energy industry (it was considered one of nature-friendly types of energy, not consuming many natural resources, not polluting atmosphere with $CO_2$ emission, and differently from fossil fuel-based energy).

The Chernobyl disaster has altered the perception of the nuclear energy industry and impacted its entire development. It is important that the Chernobyl disaster is characterised in terms of making effect to the country, Ukraine; also, it reveals how the radioactive fallout impacted the neighbouring countries to Ukraine and a large territory of Europe. Thus, it demonstrates how insecurity of the nuclear energy and accidents taking place expand the national limits of regions when radioactive contamination spread in a different way than energy regions do, landscapes reflected in geography maps form in a different way.

On the other hand, presentation of the region of Ukraine by mentioning the Chernobyl disaster creates a single-sided image putting it that being a region of the nuclear catastrophe is one of the most important (and the only?) features of Ukraine.

In terms of relevance and novelty of the data and information displayed in textbooks for forms 7 and 8, it can be noted that one part of the materials reflects basic information which does not change fast, renders specific knowledge on nuclear energy. For instance, the map of resources of minerals is present in the Republic of South Africa, which indicates coal, uranium, diamonds, copper,

platinum, gold, iron, manganese, phosphorites (Šalna et al., 2005, p. 161). Also, a map of resources of minerals is present in Canada, demonstrating oil, gas, coal and uranium (Šalna et al., 2005a, p. 241), emphasising that uranium is a nuclear fuel. Information on the Chernobyl disaster (Šalna & Sapožnikovas, 2010/2006b, p. 148–149), nuclear power plants being constructed in India (Šalna & Sapožnikovas, 2010/2006b, p. 208) and the like, would be attributed to this group of information. Another type of materials deals with statistics and facts which become outdated fast. In this regard, the textbooks used in Lithuanian schools introduced in the current chapter are old; information of the discussed type is outdated and no longer relevant. Chapters of the textbook introducing the Lithuanian INPP where production of electricity was ceased as far back as in 2009 can be an example of such information; however, in this instance, the textbook published in 2006 informs that the power plant produces 77.7 per cent of the electric power for Lithuania (Šalna & Sapožnikovas, 2010/2006a, p. 66). Nevertheless, bearing in mind present-day topicalities, a teacher should treat the given data from a historical perspective, emphasising the specific situation prevailing at that time. Other instances reflecting outdated information could be related to presentation of particular statistical data, e.g., uranium mining in various countries (Republic of South Africa, Canada, Russia) by per cent, production of electric power in various power plants by per cent, etc.

On the one hand, a teacher delivering lessons on energy and who has to use outdated textbooks presenting the INPP as an operating power plant can emphasise the closure of it during lessons. Nevertheless, a teacher must meet the challenges concerning absence of relevant information in available textbooks: one will have either to find relevant and contemporary statistical information on the volume of energy industry (which no longer includes part of nuclear energy) or to give tasks to students to find information on what power plants and how much of energy they produce in Lithuania, countries of North Europe. This would require allocating additional time and information resources.

Discussing complexity in rendering the topic on nuclear energy one may observe that lower levels of knowledge and understanding singled out by Bloom et al. ( 1956) and Anderson & Krathwohl (2001) dominate in textbooks for forms 7–8. The basic information on uranium and nuclear fuel is presented in the textbooks (for form 7); however, the textbooks do not call uranium a nuclear fuel. This explanation is developed in textbooks for form 8, which could be attributed to the level of understanding. The level of complexity in presenting information increases: in the case of form 7, the nature of nuclear power plants is revealed, and in the case of form 8, knowledge is expanded by

introducing statistical data – explaining what part of electricity is produced in nuclear power plants, the volumes are compared with power plants of other types. Thus, the initial formation of the image of an energy-focused region proceeds when different sources of energy in a particular country and region are described, and their connectedness is revealed.

## The Concept of Nuclear Energy in Forms 9–10

It should be noted that geography textbooks for form 9 pay more attention to the problems of the general concept of energy, such as geopolitical decisions, discussion of various types of energy, and energy-related environmental issues; however, the aspects of nuclear energy industry are almost left without any direct consideration. Nuclear energy is mentioned only once, when dealing with environmental topic and discussing the process of power plant operation including the usage of water from water bodies to cool reactors down. The utilised warm water is released back to the water body, and this, in turn, causes the silting up.

Nuclear energy is presented in the greatest detail in textbooks for form 10 (Šalna et al., 2006; Valančienė & Česnavičius, 2008). From the current perspective in 2020, both textbooks include quite much outdated, irrelevant material. Nevertheless, like in the textbooks for lower forms, specific basic information allowing understanding major aspects of nuclear energy is presented.

Both textbooks for form 10 present the topic on nuclear energy by pointing out the historical development of the energy industry. The textbook by Valančienė and Česnavičius (2008, p. 24) puts it that until the 19th century firewood was a major source of energy; later on, after the 19th century, as industry underwent development, coal became a major kind of fuel; and "in ca. 1960, oil became the most important source of energy, gas started being used and, later on, nuclear energy (uranium is required to obtain it)". Further goes explanation on where electricity was being produced: "first power plants were thermal steam power plants and hydroelectric power plants. Later, they perfected, wind and nuclear power plants appeared" (Valančienė & Česnavičius, 2008, p. 44). A summary for a chapter "Resources and Energy" in Šalna et al. (2006, p. 23) reveals problems of the nuclear energy industry causing threat, such as recycling and storing of nuclear waste: "The nuclear energy industry is being developed throughout the world since the middle of the 20th century. Over the time, countries accumulated vast amounts of nuclear fuel waste. It is very expensive to recycle and store it. These substances are hazardous to human health; therefore, the humankind are facing a new problem – what to do with the nuclear

fuel." (p. 23). Such approach allows drawing assumptions that students of the 10th form should find out about the development of the energy industry and economy, nuclear energy, production and recycling of nuclear fuel emerged in a specific period within that development. It is important to note that the development of nuclear energy, grounding on the text of the textbook issued in 2008, is presented not as a valuable source of energy, but also as a type of energy that causes problems (storing of nuclear fuel) to the humankind.

Historical information on the changes in consumption of energy sources and energy industry presented in both textbooks is illustrated by figures, diagrams and maps. The figure "Changes in consumption of energy resources" (Valančienė & Česnavičius, 2008, p. 23) demonstrates a historical fact stating that sources of nuclear energy appear in ca. 1965, and intensity of their consumption in 2000 comprises ca. 10 per cent of the entire energy production. The textbook by Šalna et al. (2006, p. 24) displays a figure demonstrating a curve of consumption of different types of energy over the period from 1950 to 2000. The data of the figure suggests that consumption of resources to produce nuclear energy increased twice over 50 years. A task dedicated to the analysis of this figure (Šalna et al., 2006, p. 24) suggests students investigate and comment on how consumption of fuel and energy sources changed from ancient times to the present day and to indicate the causes that resulted in that change. This topic and adjacent tasks on the historical change and dynamics of energy consumption included in the textbook reflect one of the major topics of energy geography in relation to historical changes in energy landscapes, technological and energy-related social transitions dealt with by authors analysing energy geography (Bouzarovski, 2009; Lambert, 2013, Butt, 2011). Such way of introduction of nuclear energy in textbooks reflects characteristics of geography as the "global thing" discussed by Lambert (2013) and Butt (2011) because the historical development of the nuclear energy industry throughout the world is dealt with.

In order to assess the novelty and rendering of basic knowledge of the textbook's materials, the historical approach to the development of the nuclear energy sector can be treated as important basic knowledge on the understanding of energy geography. However, it should be admitted that examples illustrating the situation of nuclear energy industry and economy (in tables, maps, diagrams) as well presented data, numbers no longer reflect the topicalities or problems of the current period. The textbooks render a concept of the change of an energy landscape; however, the "present" dealt with in the textbooks written in 2006 and 2008 does not meet the reality and present-time of 2020. Working in class, a teacher must regard the changes that took place in

the area of nuclear energy sector since that time demonstrated by facts in the available textbook and must seek to present new, relevant data.

The entire materials on nuclear energy of textbooks for form 10 can be divided into several thematic areas.

## Identification of the Significance of Nuclear Industry

Like in the case of form 8, the textbook by Šalna et al. (2006, p. 24) for form 10 has it that "uranium is a very important type of resources, required for producing nuclear energy"; and the textbook by Valančienė and Česnavičius (2008, p. 23) includes more information: points out that the fuel of nuclear energy is not only uranium, but also includes another element, thorium. Moreover, a table "Branches of economics" in the textbook (p. 43) presents nuclear energy industry as a constituent part of the energy economy, together with thermal, water and alternative energy.

The textbook by Šalna et al. (2006) describes advantages and disadvantages of nuclear energy quite in detail and consistently. The advantages of the use of nuclear energy pointed out in this textbook are the following: long-lasting, clean, because there is no impact of $CO_2$ on nature; cheap, because little fuel is required, and transportation of it is easier and cheaper; resources of fossil fuel are saved. Specific advantages are not pointed out in the textbook by Valančienė and Česnavičius (2008); however, similar emphases are made when talking about the operation of the INPP, for instance, the text explains efficiency of the nuclear energy industry, little nuclear fuel is required, there is no environmental pollution.

Drawbacks are emphasised, too: "These power plants may be dangerous and cause threat to environment" (Šalna et al., 2006, p. 32). "It is difficult and expensive to recycle radioactive substances. The sites for storing the waste are insufficient all around the world; it is dangerous to human health to transport nuclear fuel; the risks of harming people and environment is higher than the benefit. The safety systems of the power plants cannot completely prevent from severe earthquakes and terrorist acts." (Šalna et al., 2006, p. 33). Materials on the INPP provided in Valančienė and Česnavičius (2008) putting it that the problem lies in old-type reactors (even though it does not mention that the type is the RMBK, like in Chernobyl) could be an illustration to the statements of this textbook; the latter has it that, after the disaster at the Chernobyl Nuclear Power Plant, the trust in the nuclear energy system has decreased; nevertheless, it also notes that "this is the only known area of future energy industry which will be able to accommodate the energy demand" (Valančienė &

Česnavičius, 2008, p. 47). Interesting to note that, in such a way, a provision focusing on students' critical thinking in assessing nuclear energy from different perspectives, seeing both positive and negative aspects is being developed. Both textbooks for form 10 have questions intended for generalisation of the concept of nuclear energy: "What advantages and disadvantages exist in terms of nuclear energy? What is the perspective of nuclear energy industry?" (Valančienė & Česnavičius, 2008, p. 46).

However, it can be observed that the textbook provides a conclusion on the nuclear energy sector as the only known type of future energy industry, which could be treated as a clear pro-nuclear attitude and narrative supporting nuclear energy. It is important to underline that back in 2008 Lithuania still maintained a vision of a state developing the nuclear energy industry. The second block of the INPP would be closed in 2009; Lithuania maintained a hope to build a new nuclear power plant up until the referendum held in 2012, which prevented from construction of the new nuclear power plant.

Such introduction of significance of nuclear energy raises both a question and a doubt whether the topic of globality is sufficiently developed, which, according to scientists (Lambert, 2013; Butt, 2011), is important to geography as "a subject of survival" and "curriculum for the future", treated as an important purpose of geography as a subject – to raise questions about global challenges, global interconnectedness issues. As Thoyre and Harrison (2016) put it, globality is connected to problems of sustainability, questions of geopolitics, environmental crises and catastrophes. The analysis of the content of textbooks for form 10 reveals that the aspect of globality of nuclear energy industry is more emphasised not through the prism of the environmental protection topic (which would manifest as concern about insecurity of nuclear energy and effect of radiation on environment all around the world), but by underlining the global geoeconomics aspect, when nuclear energy is seen as the only type of energy than can meet the demands for energy in the future economy worldwide.

Analysing how the development of energy literacy proceeds, it is supposed that the naming of the significance of nuclear energy in textbooks, though, allows students form critical civic stance or attitudes (grounding on Van der Horst et al., 2016; Fowler, 1976, cit. DeWaters et al., 2013) because the context is presented by providing both positive (nuclear energy as cheap, making no harm to environment, effective) and negative (Chernobyl disaster, insecure equipment) aspects of the use of nuclear energy.

Moreover, grounding on the elements of energy literacy proposed by DeWaters et al. (2013), the affective element stands out, too, because students form the view (concern), stance (understanding that something should be

changed) and responsibility. No doubt, the cognitive element is being developed as well, because basic knowledge on the significance of nuclear energy is obtained. From the point of view of complexity of the competence (Bloom et al., 1956; Anderson & Krathwohl, 2001), texts in textbooks for form 10 are oriented to higher levels: analysis, synthesis and evaluation because advantages and disadvantages of nuclear energy are presented; problem questions about complexity of recycling and storing of nuclear waste are raised; and tasks requiring considerations on perspectives of nuclear energy are included.

## Revealing the Role of Nuclear Energy in the World

Both textbooks for form 10 include materials on nuclear energy and its significance in the world. The textbook by Šalna et al, (2006, p. 32) identifies the geopolitical aspect, i.e., "the decision to use nuclear energy greatly depends on the governmental views and public opinion" (p. 32). The reasons for nuclear industry development and countries developing it are indicated mentioning that "nuclear energy is used by the countries that lack fossil fuel" (p. 32). The textbook by Valančienė and Česnavičius (2008, p. 45) also has it that nuclear power plants are constructed on sites which lack other sources of energy.

Here, the development of energy literacy stands out when the geopolitical aspect of the energy system is emphasised (Fowler, 1976, cit. DeWaters et al., 2013; Van der Horst et al., 2016). Nuclear energy is characterised as an effective type of energy which may accommodate the needs for energy in specific regions; decisions on closure of the INPP are discussed in relation to national or global decisions.

Both textbooks introduce the countries and scope of the development of nuclear energy industry. These two point out that there are 30 countries worldwide which run nuclear power plants. Valančienė and Česnavičius (2008, p. 45) also note that the largest numbers of power plants are in the USA, France and Japan. Moreover, it states that the largest nuclear power plant in the world is the Fukushima Nuclear Power Plant (in Japan), comprising 10 operating reactors, and in total Japan "runs 16 nuclear power plants, electric energy is being produced by 52 reactors"; illustrations are provided on how nuclear energy constituted 8 per cent in 1990 and 12 per cent in 2007 (Valančienė & Česnavičius, 2008, p. 157). Here it is important to note that the textbook under analysis was written earlier than the disaster in the Fukushima Nuclear Power Plant that took place in 2011; therefore, it is obvious that this accident is not introduced in the textbooks.

The volume of production of nuclear energy is described in both textbooks. Šalna et al. (2006, p. 32) present a table "Ratio of electrical energy produced in nuclear power plants in 2004" which lists the countries running nuclear power plants in the world, percentage ratio of produced electrical energy and numbers of reactors per country. There is a discussion on the countries that run most of nuclear power plants and produce the largest parts of electrical energy there (Šalna et al., 2006, p. 46); whereas the textbook by Valančienė and Česnavičius (2008, p. 45) includes a table "Spread of nuclear power plants across countries, 2006" which indicates the numbers of reactors and their power in MW in various countries. The data is supplemented with the tasks presented in the teaching materials by Dijokienė (2016) for form 10; the said tasks ask to point out the states where electricity is produced at nuclear power plants, by choosing correct options from the list: Brazil, India, China, the Netherlands, Norway, the USA, Poland, Russia, France and the Republic of South Africa. Another task that allows consolidating the information presented in the textbooks deals with the exploration of a cartographic scheme to complete the tasks: to list the European states which currently run largest numbers of reactors; to indicate 3–5 states that produce nuclear energy; and to find the European countries which have no nuclear power plants; all insights must be substantiated.

The textbook by Šalna et al. (2006) lists the technological and economic aspects in ensuring safety, which is linked to high financial expenses. Another aspect to be noted in relation to this textbook is that the text emphasises the decrease in the development of nuclear energy industry impacted by the Chernobyl disaster.

The presentation of the significance of the nuclear energy sector at the global level in the textbooks complies with the concept of energy geography defined by Solomon et al. (2004) and Calvert (2016) because the texts partly reveal the aspects pointed out by the authors: identification of local factors explaining observed spatial patterns of investments in the energy sector and the distribution of energy technologies in the world (networks of the spread of nuclear power plants, capacities of nuclear power plants are presented); identification of environmental and economic risks by pointing out that expensive technological solutions in relation to the nuclear energy sector limit the development of this type of industry. Connecting this to the energy geography approach, the authors of the present research emphasise the significance of formation of the civil position aspect, too, since students get an opportunity to evaluate the actions linked to nuclear energy industry with regard to national (Lithuanian) and global (nuclear power plants worldwide, their capacity, expenses on technological solutions) decisions (according to Van der Horst et al., 2016).

When dealing with nuclear energy in the world, it is highly important to note the significance of novelty and relevance of the materials in the textbooks. In this case, information presented in Lithuanian textbooks is outdated in many instances because basically the distribution and capacities of nuclear power plants are changing, e.g., after the Fukushima catastrophe in 2011, the Japanese system of nuclear energy industry has significantly changed; or the change in the development of nuclear power plants in some other countries (France, Finland, etc.); therefore, a teacher working with materials of the textbook must critically evaluate such changes, select materials and data illustrating the changes.

It can be noted that, when linking to the energy literacy elements pointed out by DeWaters et al. (2013), materials on the significance of nuclear energy in the world as presented in the textbooks is oriented towards the cognitive element, and, from the point of complexity of the competence, it would meet the level of knowledge and understanding because essential information is rendered.

## Revealing the Threats of Nuclear Energy

The textbook issued in 2006 (Šalna et al., 2006, p. 32) for form 10 describes the threats related to nuclear energy quite in detail, pointing out that they occur from radioactive pollution, storing of radioactive substances and that society assess this area negatively.

However, it was observed that textbooks for form 10 do not elaborate narration on the largest disaster of the nuclear power plant at Chernobyl, the most highlighted and strongest anti-nuclear narratives. Valančienė and Česnavičius (2008, p. 48) provide a photograph "Reactor of the Chernobyl Nuclear Power Plant (Ukraine)"; however, for a reader, it may be not clear from a provided image that it depicts the situation after the disaster happened. There is no text on the disaster supplementing this photograph. Moreover, this textbook only mentions the aspects of accidents in nuclear power plants at the end of the chapter dedicated to the energy industry (p. 46), presenting the volume of the Chernobyl disaster in short: "The level of radiation on the territory of the nuclear power plant reached 20–25 micro-r-units per second. This exceeded the permissible norm more than a thousand times," without providing more details. Even though these textbooks only quite fragmentarily develop the element of nuclear power plant catastrophes, still, the tasks of the teaching materials by Dijokienė (2016) include a creative project assignment on the topic dealing with the Fukushima Daiichi Nuclear Power Plant catastrophe that took place on 11 March 2011, following the earthquake. The task has it that, after the bombing

of Nagasaki and Hiroshima, Japan has chosen the forms of nuclear power production, planned to have produced over 50 per cent of the energy consumed in the country at nuclear power plants by 2030. A question why did Japan make such a choice is posed to school students. To answer the question, students have to use various information sources and prepare for a discussion on why Japan needs so many nuclear power plants; moreover, they have to prepare a presentation "The Future of Energy in Japan". Such approach to the presentation of the materials reflects a connection between two largest catastrophes of nuclear power plants; a teacher using both teaching means can develop a relevant up-to-date discussion on assurance of safety of nuclear power plants, causes and consequences of catastrophes and the future prospects of nuclear energy.

One of the threats pointed out by Šalna et al. (2006) as a separate issue focuses on safety of nuclear fuel waste. It emphasises that "this is a potentially hazardous product resulting from nuclear energy activity: its concentration encompasses 98 per cent of all radioactive materials", and "it is difficult to solve issues of storing accumulated nuclear fuel waste and conserving old reactors. Currently, the nuclear fuel waste is usually stored in isolation from environment in reliably controlled reservoirs. Quite many of them are kept dug in the soil." (Šalna et al., 2006, p. 32). The text has it that the recycling of nuclear fuel is a complex and expensive technological process; therefore, only nuclear states, the UK, France, Russia and Japan, can afford it. Also, it points out that states that do not have such complex technology would prefer to pay for acceptance and recycling of the waste. The text is illustrated by a figure (p. 33) "Nuclear fuel from mining to storing waste". The text is supplemented with a task evoking a discussion by providing arguments in favour of or against the development of the nuclear energy sector (p. 32); and a task-question at the end of the chapter is dedicated to repetition of knowledge on nuclear waste requiring answer yes or no: "The storing of radioactive waste does not cause any big problems." (Šalna et al., 2006, p. 46).

The identification of threats allows forming environmental literacy, problem-solving skills highlighted by Van der Horst et al. (2016) related to the development of energy literacy because the textbooks present texts on danger posed by nuclear waste, conservation of old reactors. Relating to the elements of energy literacy proposed by DeWaters et al. (2013), materials of the textbook on threats and difficulties are to be linked to the affective element because statements on radioactive pollution, dangers and further situation of old reactors allow students understand and form, on the one hand, concern, anxiety about the future of the humankind; on the other hand, it may form their responsible

attitude towards consumption, critical thinking and decide on their choices (e.g. which type of energy is more suitable for use: renewable or nuclear?).

From the point of view of the complexity of the competence (Bloom et al., 1956; Anderson & Krathwohl, 2001), materials of the text, in opinion of the authors of the present paper, comply with the levels of analysis or synthesis because quite complex problems on technological solutions which can be made to recycle and store nuclear waste are presented; problems revealing distrust of society in the nuclear energy system are mentioned. Such approach in presenting the materials allows a teacher arrange various discussions, debates which would help students gain skills of critical thinking.

## Review of the Situation of Nuclear Energy in Lithuania

Both discussed textbooks quite consistently present the situation of nuclear industry in Lithuania. Texts emphasise the situation of the time when the textbooks were being prepared (in 2006). However, the textbooks include specific links or considerations on likely perspectives, even though they are not very clear or firm. In such a way, an actual political, economic situation of that time when Lithuania was preparing for the closure of the second block in 2009 and there were no clear visions concerning the future of nuclear energy is reflected. At that time, opportunities of construction of a new nuclear power plant jointly with Latvia and Estonia were being discussed. When delivering nuclear energy topics during geography lessons nowadays, it is clear that the projected prospects did not come true when the referendum of 2012 determined the refusal of constructing a new nuclear power plant.

Nuclear energy in Lithuania is discussed in the following aspects: by introducing the concept of sources of energy, indicating the consumed amount of nuclear fuel to produce electrical power, "in the energy balance for 1980–2005 it constituted 34–37 per cent" [comparing to other sources of energy] (Šalna et al. 2006, p. 38); the type of energy is discussed by pointing out that nuclear the energy system also operates complementing other types sources: "In Lithuania, the largest part of electrical energy is produced by power plants of three types: hydroelectric, thermal and nuclear" (Šalna et al., 2006, p. 45). The volume of this type of energy industry is illustrated by a diagram (Šalna et al., 2006, p. 39) "Production of electrical energy in Lithuania" which demonstrates the types of power plants and changes in production of electricity in 2003 and 2005; whereas the textbook by Valančienė and Česnavičius (2008) presents corresponding numbers demonstrating that the INPP is one of the most powerful power plants in the world. The textbook by Šalna et al. (2006, p. 38) comprises

a map "Lithuanian system of energy" which depicts all types of power plants in Lithuania related to production of energy that were operating at the time of writing the textbook under discussion: the nuclear power plant, thermal power plants, hydroelectric power plants, oil pipelines, gas pipes, oil refinery and oil processing plants. Such rendering of the material shows that the rendering of nuclear energy industry in line with other types of energy facilitates students' better understanding of the map depicting the energy system and the structure of the energy economy.

Moreover, both analysed geography textbooks for form 10 also present the prospects of the INPP linked to geopolitical and economic aspects. First, the textbook by Šalna et al. (2006) points out that reactors of the INPP are analogous to those in the Chernobyl Nuclear Power Plant; their "time of exploitation has already expired; therefore, there is a grounded consideration that the power plant poses threat" (Šalna et al., 2006, p. 39), which would be linked to technological and environmental aspects. However, both textbooks provide details supporting the view that obligations undertaken before entering the European Union are one of the major causes to close the INPP. In such a way, the geopolitical factor is underlined as one of significant aspects in terms of the closure of the INPP. Moreover, perspectives of the development of nuclear energy industry are highlighted by stating that Lithuania, jointly with Estonia and Latvia, "have come to an agreement to jointly build a new, modern nuclear power plant in Lithuania" (Šalna et al., 2006, p. 39).

The economic aspect of the closure of the INPP is emphasised by the textbook by Valančienė and Česnavičius (2008), putting it that this might disturb the structure and prices of energy sources because too "little of local renewable resources are used" (Valančienė & Česnavičius, 2008, p. 49), the funding of the closure of the INPP from the EU funds allocated for mitigating negative financial, technical and social effects is pointed out. In this case, it would be appropriate to discuss on the closure of the INPP as a complex process in technological and geo-economic as well as geo-political and social aspects; therefore, evaluations of this process cannot be unilateral.

Materials provided by Šalna et al. (2006) on nuclear energy in Lithuania and the INPP are illustrated with a photograph "The first block of the Ignalina Nuclear Power Plant" (p. 39) and a text of the news agency ELTA "An Electrical Bridge from Lithuania to the West" published in 2005 on the foreseen solution of the problems of electricity supply after the closure of the INPP: "Lithuania and Poland will put efforts to implement the project of the electrical bridge to the West by 2009, when the closure of the second block of the Ignalina Nuclear Power Plant is anticipated" (Šalna et al., 2006, p. 40).

To consolidate knowledge on the situation of the nuclear energy sector in Lithuania, 4 questions are given in the textbook by Šalna et al. (2006, p. 46): "How has the production of electrical power changed in Lithuania after the closure of the first block of the Ignalina Nuclear Power Plant? Predict how the system of energy industry in Lithuania will change after the closure of the INPP. What positive aspects and negative effects will the closure of this giant of economy have? Which electric power plants produce most of the energy in Lithuania? And a statement requiring an answer whether "yes" or "no": Very much of electric energy is produced at the Ignalina Nuclear Power Plant." The prognostic elements on the situation of the nuclear energy sector are substantiated in tasks of more recent teaching materials by Dijokienė (2016): school students are asked to characterise the currently existing energy sector in Lithuania and, by using the cartographic scheme, to present a prediction on the changes of the energy sector by 2020. The scheme includes the operating (in 2016) energy systems, and the role of a nuclear power plant is linked to the withdrawal from the common system. However, the materials (by Dijokienė) published in 2016 point out the aspect of further plans of nuclear energy sector developments to be discussed, as it presents a task to prepare a presentation for peers on strategic projects of Lithuania, including a plan to construct a new nuclear power plant in 2018–2020. Basically, these materials are still being used in schools; therefore, teacher's critical point of view as well as knowing and informing of students about the decisions made back in 2012 to not build the new nuclear power plant are highly important.

As observed, texts included in the textbooks for form 10 lack references to quite a unique social aspect of the nuclear energy industry in Lithuania, such as consequences of the closure of the INPP and construction of a new INPP for the nuclear town Visaginas, a satellite of the INPP, and its community.

To sum up the connections of the texts in geography textbooks for form 10 to the skills of the geographical competence being developed, it is clearly seen that the development of the skills of reading geographical information dominates because the texts render various, quite consistent information, data and concepts. Moderate orientation to the skills of cognition and investigation of environment is found, when informative materials of the texts are illustrated with tables and diagrams. Skills of orientation in area and map are slightly developed when materials of the texts are illustrated with maps and photographs. Cognition of other regions (except Lithuania) is developed very episodically, when information on nuclear energy industry in some countries of the world is presented; nevertheless, this is more of an informative kind of materials. Lithuania is a major region receiving most of the attention while discussing

the situation of the nuclear energy sector in Lithuania. Tasks presented in the texts are more dedicated to reproduction of knowledge, even though particular elements of the development of analytical skills can be recognised, too. Texts on the situation of the nuclear energy sector in Lithuania correspond to the theme of energy geography according to Bouzarovski (2009), when the change of energy landscape is identified in connection to social-technical solutions, spatial differentiation and territorial network where specific relations of power manifest.

In terms of assessment of introductory materials in the textbooks for form 10 in the aspect of energy literacy dimensions (DeWaters et al., 2013), it can be stated that cognitive and behavioural elements prevail because presentation of the historical development of the nuclear energy industry renders basic knowledge, and the aspect of knowledge on the technological development forms attitudes towards future behaviour in the aspect of consumption of this type of energy.

In relation to the development of energy literacy skills characterised by Van der Horst et al. (2016) and Fowler (1976, cit. DeWaters et al. (2013)), it can be observed that materials on nuclear energy in the textbooks for form 10 allow developing civic attitudes and gain analytical skills, when students are given tasks inviting to predict the situation after the closure of the INPP, change of the energy economy, and perceive this type of energy as manifestation of science and technology as well as of its role in both national and global area. In such a way, students discover the historical development of the nuclear energy industry, which allows understanding the effect of this area of energy on societal processes: increase of energy production, booming of industry, and, however, an issue of the danger of nuclear waste is raised.

Regarding the complexity of energy literacy (according to Bloom et al., 1956; Anderson & Krathwohl, 2001), it is observed that the materials on nuclear energy of Lithuania are characteristic of complexity and complication; therefore, these would be attributed to the levels of synthesis and evaluation. Such conclusions are drawn by the researchers of this case because even though presentation of informative materials (tables, numbers) is more focused on the development of analytical skills in relation to why particular processes happened (closure of the nuclear power plant, threat of the reactor etc.), the following questions project expression of profound insights on likely changes in energy industry, predicting the situation after the closure of the INPP.

Obviously, the aspect of outdated information cannot be left unnoticed because the materials presented in the textbooks deal with topicalities that were relevant in 2006, e.g., agreements to build a new nuclear power plant,

which at the present moment are no longer significant because they will not be implemented, though. Thus, teachers must very carefully analyse the materials themselves and present what may be relevant in the contemporary time, e.g., point of view towards presently being built Astravets Nuclear Power Plant in Belarus and issues of electricity supply from this power plant.

## The Concept of Nuclear Energy in Forms 11–12

When revealing the concept of nuclear energy, the analysis of two geography textbooks: Česnavičius and Gerulaitis (2008/2007) "Bendroji geografija" (Lith. General Geography) and Česnavičius et al. (2010/2008) "Regioninė geografija" (Lith. Regional Geography), has been carried out. The analysis of the content of these textbooks pointed out that several new aspects, such as urban and military, were added to the context of nuclear energy and a topic of technological progress was moderately developed.

Quite a large part of materials on nuclear energy displayed in the textbooks repeats what was presented for lower forms, especially form 10, including small additions. Statements about production of electric power given in the textbooks could be identified as repeated materials: "Majority of electricity is produced in thermal, nuclear and hydroelectric power plants" (Česnavičius & Gerulaitis, 2007, p. 188); nuclear energy started being used half a century ago, and power plants are built on sites which are poor in other energy resources; uranium, more rarely thorium, is used for production of fuel (p. 188); electrical energy comprises: thermal, nuclear, hydroelectric and alternative energy (p. 184); nuclear power plants, having little effect on environment in terms of pollution, are efficient; the utilisation of nuclear fuel waste and danger of nuclear fuel in terms of likely explosions are mentioned.

The repeated materials in the textbook by Česnavičius and Gerulaitis (2008/2007) can be those dealing with the information on the INPP because, like for form 10, it indicates that these reactors are among the most powerful ones in the world; but, differently from form 10, their type, RBMK-1500, is mentioned (p. 191). It is stated that they are considered to be unreliable. It is mentioned that the INPP was closed; however, no causes are revealed (like in form 10, due to the obligations undertaken when entering the EU, old model (insecurity of the Chernobyl type reactor). The tasks included in the exercise book by Šalna et al. (2012) moderately expand the materials presented in the textbook texts because there is a set of tasks on nuclear energy worldwide and particularly in Europe, displaying 6 texts from information publications on the nuclear energy sector situations in Germany, Japan and the EU; the safety issues in relation to nuclear

power plants in various countries of the world; the development of the nuclear energy industry in China; and the technological use of a nucleus in space industry. Students are asked questions requiring submission of arguments: for instance, why are nuclear power plants being massively closed in Japan and other countries since 2011; how will this impact national economies; what was the impulse for the change in the nuclear energy sector since 1989; and why do some countries, despite emerging threats, continue developing the nuclear energy industry.

When analysing both textbooks for forms 11–12, it is observed that they both could supplement each other due to differences in their contents. The textbook "Regioninė geografija" (Lith. Regional Geography) by Česnavičius et al. (2010/2008) focuses on specific characteristics of regions and countries; therefore, one can find materials on nuclear energy industry of separate countries or regions, Great Britain, China, USA, Brazil and Republic of South Africa, in it; nevertheless, the information is not highly detailed, is presented in different volumes, e.g. nuclear energy industry of Great Britain is introduced following the principle of historical consistency: when the first nuclear power plant was built, how volumes of energy produced in nuclear power plants changed, what are the sources of the fuel, how many reactors operate. The nuclear energy in Japan is presented by relating it to the aspect of militaristic use of nuclear energy, telling that the first experience of the state in terms of nuclear energy was undergone as one of the largest tragedies, the dropping of nuclear bombs on Hiroshima and Nagasaki. Nuclear industry of other states or regions, Asia, USA, China, Brazil, also Japan, is presented in this textbook by displaying numbers or even less: presented maps demonstrate references to the sites of uranium mines or locations of power plants. Materials on nuclear power plants in Japan, the largest nuclear plant in Japan, Fukushima, containing 10 operating reactors (p. 188) presented in the textbook by Česnavičius and Gerulaitis (2008/2007) could supplement the materials of the earlier-mentioned textbook resulting in a more comprehensive view of nuclear industry in Japan.

Such character of materials on nuclear energy presented in the textbooks allows the authors of the research draw connections to the characteristics of global understanding of energy and energy literacy defined by Solomon et al. (2004) and Calvert (2016): this information allows students understand the changes in the energy supply-chain, how energy technology diffuses within and between nations; and mapping regional variations in energy production, distribution and use. Also the textbooks include the aspects which were not introduced in earlier forms or only presented in brief, not further developing: aspects of urbanistic, militaristic, and scientific and technological progress.

## Social and Urban Aspects of Nuclear Energy

One of the aspects introduced in the textbook by Česnavičius and Gerulaitis (2008/2007) deals with the connection between nuclear energy industry and foundation of settlements. One of the social aspects linked to the effect of the nuclear energy industry is included in the exercise book (Gerulaitis & Bačkienė, 2009) in the form of a task asking students to classify the causes of forced and voluntary migration of residents, while indicating the example of an environmental disaster, the explosion of the Chernobyl Nuclear Power Plant. The foundation of settlements was only mentioned in lower forms; the town of Visaginas was identified; however, more details were not provided. The first more comprehensive discussion on Visaginas as a satellite town constructed to serve the nuclear power plant is presented in the textbook for forms 11–12 (Česnavičius & Gerulaitis, 2007). Since the textbook by Česnavičius and Gerulaitis (2008/2007) designed for form 11–12 pays much attention to geo-political and geo-economic aspects, it also manifests when talking about problems of Visaginas, the town of the INPP: "4 reactors could be constructed in the power plant (2 were built). After the changes in the political and economic conditions, a part of the planned town construction remained unfinished." (Česnavičius & Gerulaitis, 2007, p. 57). In this textbook, the topicalities of the closure of the INPP are related to economic-financial aspects, as it puts it: "Early closure of the Ignalina NPP without having required funding from the EU and other Western states and international financial institutions would be an unbearable burden for the national economy to carry" (Česnavičius & Gerulaitis, 2007, p. 191). The financial means for the closure of the INPP are not directly allocated to the power plant only, but also they are dedicated to the restructuring of the economy sector of energy while developing renewable energy resources. The exercise book by Šalna et al. (2012, p. 26) includes a task to express one's own opinion concerning the necessity of the project of a new nuclear power plant in Visaginas.

Also, the text mentions the funding for the solutions of social problems occurring in Visaginas after the closure of the INPP. The text of the textbook (Česnavičius & Gerulaitis, 2007, p. 191) has it that, after the closure of the INPP, the nuclear energy industry system in Lithuania is planned to be developed in cooperation with companies of other countries – France, Russia, USA and Canada. Also, a laconic emphasis is put on the prospects of town development, when assessing the INPP as a larger employer in the town, and after the loss of it, occurring social problems; moreover, it underlines that specific changes in performance are foreseen: "Now different activities, not related to

the nuclear power plant, are being developed, small businesses and trade prevail in Visaginas. Several "scenarios" for the future of Visaginas town have been designed." (Česnavičius & Gerulaitis, 2007, p. 57).

The presented social and urban aspects of nuclear energy are linked by the authors of the research to the formation of civic attitudes pointed out by Van der Horst et al. (2016), Fowler (1976, cit. DeWaters et al. (2013), when it aims at evaluation of the decisions made in relation to energy at national and global levels. Nevertheless, the introduction of the social situation in Visaginas lacks comprehensiveness. Texts on the volume of construction of the INPP, expansion of the town, political decisions concerning the closure of the INPP and further prospects allow students form quite a comprehensive view and understanding of nuclear industry as a strategic factor supporting national economy, that construction of the nuclear power plant is also related to infrastructural, social decisions (town, maintenance scheme); however, this technology becomes outdated and, therefore, political decisions concerning the closure or construction of a new power plant are being made. The case of Lithuania demonstrates that there can be a closure scenario which essentially changes both national energy system and social structure of a single town.

In terms of the level of complexity of the competence (following Bloom et al., 1956, Anderson & Krathwohl (2001)), the authors attribute this arrangement of the contents in the textbooks to the striving to develop the competences of the synthesis level because quite complex questions encompassing different aspects of nuclear industry are raised, e.g., construction of the nuclear power plant, closure of it and solution of social problems; closure of the nuclear power plant and collaboration with other states; and closure of the nuclear power plant and economic issues of the funding. Of course, assessment of the presented outdated facts or data should not be forgotten. Facts on the capacity of the INPP can be treated as basic information, for instance, when talking about types of nuclear power plants, capacity of reactors. However, when analysing the social problems of Visaginas town at the present moment (more than 10 years after the publishing of the textbook), one may face difficulties, since there is no available sufficient information on what is taking place in the town now.

## Militaristic Aspects of the Use of Nuclear Energy

Basically, a militaristic aspect is a completely new one linked to the nuclear context, occurring in the textbooks for forms 11–12. The text by Česnavičius and Gerulaitis (2008/2007) points out that "nuclear technologies created nuclear weapons, a huge threat to the humankind, too" (p. 165). Nevertheless, this aspect

is not developed in detail and comprehensively because the presented facts are quite fragmentary and do not help to create a sophisticated and complex concept of nuclear weapons, their effect and geopolitical aspects. First, the aspect of nuclear armament is introduced through a narration about the nuclear bombs that were dropped on Nagasaki and Hiroshima during the US war with Japan in 1945 (Česnavičius & Gerulaitis, 2007, p. 135). Explanations elaborate that nuclear armament causes tension in society, even though after the Cold War the situation became more moderate because the Treaty of the Non-proliferation of Nuclear Weapons was signed, and some countries (Kazakhstan, Belarus, Ukraine, the Republic of South Africa) introduced nuclear disarmament. Seeking to illustrate information on nuclear weapons, a table demonstrating which 8 states dispose nuclear weapon is given (Česnavičius & Gerulaitis, 2007, p. 137).

One of the topics deals with the strengthening of geo-economic and geopolitical influence of China through the military power: "The Chinese possess weapons of mass destruction, carry out nuclear weapon testing" (Česnavičius & Gerulaitis, 2007, p. 135). At the end of the text on nuclear armament (p. 137), a glossary is given, including an explanation of the concept "nuclear club" (Russ. ядерный клуб), an unofficial joint title of the states creating and possessing nuclear weapons.

It is important to note that this discussion of nuclear armament across the world is not related to nuclear energy industry, as given in the textbooks. The authors of this chapter hold the opinion that a critical analysis of nuclear energy should encompass the ability to recognise the connections between military and peaceful use of the nucleus. From the historical perspective, the peaceful nuclear energy in the USA, Russia derives from arms industry. On the other hand, setting up the infrastructure of nuclear energy facilities in separate countries may create preconditions for nuclear weapons industry.

From the point of energy literacy, the militaristic aspect of nuclear energy presented in the textbooks can be linked to the understanding of energy as science and technology as well as of its role in the national and global space put by Fowler (1976, cit. DeWaters et al. (2013)) in connection to geopolitical aspects, too. It was observed that the materials present another important aspect, the concept of nuclear weapons, by indicating the danger they may cause. The authors of the research observe that the materials could be more detailed, consistent and attractive to students; however, even such presentation of information like in the textbooks under investigation has obvious significance because the data on states having nuclear weapon is introduced, countries that develop these technologies of armament are identified. Connecting with the elements

of energy literacy proposed by DeWaters et al. (2013), the militaristic nuclear aspects found in the textbook texts would correspond to the development of the affective element revealing the formation of pacific, anti-militarist attitudes, responsible behaviour because not only material on the dropping of the nuclear bomb on Japan is presented, but also questions on the nuclear armament of the present time are raised.

Even though the textbooks put major emphasis on the dropping of nuclear bombs on Japan, still a teacher delivering the curriculum could link to contemporary reality of armament, e.g., ballistic missiles testing in North Korea and programmes of uranium enrichment in Iran, which would enable connecting the concept of nuclear energy with the statements of Thoyre and Harrison (2016) having that energy can be a means to consider the questions of environmental sustainability and security in the global world.

## Scientific and Technological Progress and Nuclear Energy

The use of nuclear energy as a result of technological and scientific progress is another aspect to be singled out in the textbooks for forms 11–12. In the textbook by Česnavičius and Gerulaitis (2008/2007), nuclear energy sector is linked to the development of science and technology by stating that this branch of economy is open to science (p. 195); the table presented on p. 165, "OECD classification of industry sectors which are open to science (adapted)" indicates that nuclear energy is attributed to the area of industry of high technologies of moderate complexity, and it is grounded with a statement about inventions in the area of physical sciences intended for perfection of the energy sector (p. 165). Statements in the exercise book (Gerulaitis, Bačkienė, 2009) dealing with the invention of the nuclear weapon and the launching of a nuclear reactor are related to the aspect of scientific and technological progress changing the geopolitical map because there is a task to classify various events according to importance in a particular period of time and to write about significance of these events. A statement putting that the society confidence in nuclear energy after the Chernobyl disaster decreased, however, and new technological solutions allow creating new and reliable nuclear reactors which are the fundamentals of the future power plants can be linked to the technological progress of nuclear energy sector: "Currently, this is the only known area of future energy industry which can meet the energy demand" (Česnavičius & Gerulaitis, 2007, p. 189).

It can be emphasised that the importance of the technologies of modern energy industry is underlined, though it is not elaborated in detail; nevertheless,

an idea about modernisation of nuclear energy sector, inventions in the physical science, is raised, and nuclear industry is identified as the only area warranting the increasing needs for energy. This material reveals an approach expressed by Fowler (1976, cit. DeWaters et al. (2013)) on energy literacy, having it that an understanding of energy as science and technology as well as of its role in the national and global space is needed. The topic of globality is dealt with by introducing technological aspects of nuclear energy and stating that this type of energy will remain the most important in ensuring the energy needs throughout the world. This allows students design a global whole view and perceive that nuclear energy is important to the entire world.

## Generalisation on the Explanation of Nuclear Energy in the Textbooks for Forms 10–12

One can recognise that this presentation is highly purposively oriented to the geo-economic aspect because economic matters are emphasised the most: extraction of nuclear (uranium) raw materials, volumes of production of nuclear energy, number of power plants, states that produce nuclear energy. This corresponds with the object of energy geography, the perception of how global infrastructure of nuclear energy sector is created, which countries and how they develop this energy industry. This aspect is highly expressed in the textbooks through presenting data on nuclear energy industry, describing examples. Texts of the textbooks reveal significance of the use of nuclear energy in the common infrastructure of separate countries or regions comparing the volumes of consumption of nuclear energy with other types of energy, volumes of nuclear fuel processing with other kinds of fuel. However, having evaluated the formation of energy geography as a holistic image of energy while discussing economic models of various countries, their geo-political and geo-economic interests in the area of nuclear energy, this aspect is elaborated quite superficially.

Less attention is paid to the consumption of nuclear energy, as a global phenomenon causing the environmental effect worldwide. In this approach, materials of the textbooks introduce the contradictions of the phenomenon of nuclear energy. They underline that nuclear energy is clean, pollution-free in terms of $CO_2$ emission and efficient because low consumption of fuel is required, the only one which can meet high demand of consumption. On the other hand, some statements deal with the threats posed by this type of energy, such as consequences of accidents and catastrophes, occurring insecurity caused by aging technologies of reactors, recycling and storing of waste fuel.

When dealing with development of energy literacy, one can put it that the textbooks for forms 10–12 display the cognitive and behavioural elements because the materials on nuclear energy are presented through comparison of various data, pointing out topicalities, which results in encouraging students analyse, assess and evaluate; make decisions; and form attitudes and responsible behaviour. If emphasising the complexity of the competence of energy literacy, it could be stated that materials of the textbooks for forms 10–12 are oriented to higher, more complex, i.e., analysis and synthesis, levels of evaluation.

No doubt, the aspect of outdated textbooks should be pointed out once again, which results in treating part of the information as historical materials only, no longer relevant in the present time. Due to this reason, teachers face quite a complicated task to select modern topicalities, data and information which would be suitable, reliable and important today.

## Conclusions

In the course of the research, while carrying out the analysis of scientific literature, the thematic field of energy literacy and energy geography was pointed out. Grounding on these concepts, the authors analysed the national curriculum of geography and geography textbooks. The national geography curriculum emphasise competences of cognition of regions, reading of geographical information, maps, orientation in area and scientific research competences. These competences are related to the development of energy literacy.

The theme of energy geography (in this case, exploring nuclear energy in depth) is elaborated in the textbooks by indicating the competence of cognition to be developed as projected in the national curriculum. The textbooks introduce nuclear energy in various regions of the world to students: where uranium is processed, what countries and regions develop nuclear energy industry, and what is the role of nuclear energy sector. The development of the theme on nuclear energy in the analysed geography textbooks involves major aspects of energy geography: economic, geopolitical, environmental and social. However, most of the attention is paid to the economic aspect: the diversity of energy sources, traditional and new sources of energy, energy production in the world and particular regions are discussed. Regions and countries of the world where mining of uranium take place, nuclear power plants operate are discussed.

The textbooks form the concept of energy regions helping students understand the spatial patterns of the energy sector, when the energy economy comprises several different sources of energy and nuclear energy industry constitutes an important part of national economies. Nuclear energy is

discussed in connection with other types of energy (hydro-electrical, thermal, renewable resources) and, in such a way, students can form a more general concept of the energy economy.

The textbooks discuss the development and change of nuclear sector as a branch of industry. The diversity of energy landscape, technological and social changes related to energy is presented. However, a new, contemporary approach to the nuclear energy, when it is no longer treated as the only prospective field of energy use since more attention in global economy and political discourse is focused on renewable sources of energy, green economy as the field of the future, is not revealed.

The textbooks introduce outdated information, since Lithuania no longer produces nuclear energy; therefore, this source of energy is not part of the field of present-day and future energy system. These significant changes in the energy landscape and political provisions are reflected in a major document on energy development, the Lithuanian National Energy Independence Strategy (2018), emphasising the modern environmental, sustainable aspects, such as production of power and electricity from renewable resources (biofuel, sun, biomass), engagement of citizens in the area of energy production and consumption, which is directly connected to stimulation of energy-focused participation and development of energy literacy.

Another area that presents nuclear energy deals with the environmental aspect emphasising potential insecurity of nuclear energy, damage and threats of it to people, nature and environment. This topic is developed by presenting nuclear accidents (Chernobyl disaster), radioactive pollution, potential insecurity and problems of storing of radioactive waste. Comparing the volume allocated to the discussion of this topic with the volume related to the economic aspect, it is observed that the environmental aspect is given far less attention than the economic introduction of nuclear energy.

Moreover, the textbooks also present the social aspect of nuclear energy when dealing with connections between nuclear energy industry and foundation of settlements. However, this aspect is developed much less in comparison to the economic one.

The analysis of the textbooks revealed growing complexity of the development of geographic competences when dealing with nuclear energy (Bloom et al., 1956, Anderson & Krathwohl, 2001) in the aspect of the cognitive levels. In the national curriculum, the theme on energy is presented following the principle of consistently growing complexity, through transition from the level of knowledge and understanding in forms 7–8 to the development of higher skills (analysis, synthesis) in forms 9–12. Materials of the textbooks, as element

of implementation of the curriculum, reveal that the aspect of energy is also developed quite consistently, through all levels, starting with knowledge in lower forms and moving to more complex levels in senior forms. When talking about nuclear energy in form 7, uranium is introduced; and in more senior forms uranium is explained as nuclear fuel; later, threat to environment, geopolitical processes of development of energy industry and nuclear energy sector are discussed (forms 11–12).

The research demonstrated that the national curriculum did not include direct connections to energy literacy; however, preconditions for the development of cognitive, affective and behavioural dimensions of energy literacy are created. In the textbooks, the theme of nuclear energy is mostly linked to the cognitive dimension, when basic knowledge of numbers and facts is obtained, comparisons are presented, e.g. volumes of nuclear fuel processing in different countries, changes in nuclear energy in different regions, and depiction of the process of recycling of nuclear waste. The formation of other dimensions, i.e., behavioural and attitudinal (affective), is given little attention, and the development of these components is quite episodic.

When implementing the geography curriculum and using the geography textbook to deliver the topic on energy, teachers face basic problems: it is not clear how the theme of energy meets the development of energy literacy, textbooks display outdated factual information, it is difficult to trace the consistency in the formation of the competences. To make the process of development of energy literacy consistent, grounding on the findings of this investigation, it is recommended to link the formal curriculum to non-formal activities, which could be implemented by employing the resources of educational tourism. The educational route of nuclear tourism in the INPP and Visaginas town being designed by the researchers that was mentioned at the beginning of the chapter can facilitate teachers gaining the most relevant information on the situation of energy industry (including nuclear), complexly forming the cognitive, affective and behavioural dimensions in energy literacy.

The analysis of the geography curriculum and textbooks helped the researchers to better perceive how it was possible to bring the content of the nuclear tourism route, as non-formal education, closer to formal education (in this case, the geography curriculum). Within the route, the information on the INPP may be introduced as a moment of the historical development of energy sector in Lithuania, i.e., by presenting that when the INPP operated it was a very significant part in the development of the entire economy of Lithuania; however, the economic, political and social changes that took place after the closure of the power plant made a significant impact on the context of energy system

and the development of the whole country. In this case, the route may represent the situation of the closure of the INPP, the changes, current energy sources-focused map (underlining that nuclear energy is no longer produced and other types of energy are becoming more important) and available prospects for the development of energy sector. Knowledge on the INPP can be connected to the concept of the changing energy landscape.

The route could include a relevant revelation of the social aspect of energy production and use because exactly in real environment (Visaginas town) one can present and perceive the way how nuclear industry influenced social processes: foundation of mono-industrial settlements in hinterlands, participation of top level specialists of nuclear energy sector, functioning of social and cultural infrastructure. The economic, demographic, social environment of Visaginas also allows understanding how social processes take place after the closure of the nuclear power plant.

The analysis of the textbooks on geography revealed that aiming at a comprehensive concept of the phenomenon (nuclear energy) materials must be characteristic of consistently growing complexity; therefore, the projection of its presentation could ground on the logic available in the textbooks: by rendering the content growing from specific very simple concepts to more complex levels. In such a case, teachers would find the possibilities to choose: to deliver the nuclear topic consistently, starting from lower forms (forms 6–7), or choosing the logic of growing complexity of content and consistency (e.g. in form 9, starting from elementary knowledge and facts, consistently moving to the most complex geo-political, geo-economic evaluation). In such a way, it appears important to render and choose the learning strategies. Seeking to render simple information and knowledge, methods of work in groups, discussions, studying and discussing of sources can be employed both in classroom and field within the tourism route; whereas when moving to the development of more complex skills, learning strategies encompassing several skills are necessary to apply when using a virtual tourist route or visiting Visaginas. In such a case, in both formal education lessons and in the settings of non-formal outdoor education, the following methods are recommended: digital storytelling, use of the GIS, problem-based learning, project design and narrative play strategies. When applying these methods, students could perform investigations of natural and social environment employing the GIS; present relevant projects on energy consumption and environmental protection; solve relevant issues of town development (project design); and carry out investigations of a demographic situation, place and cultural identity of the town and its residents (digital storytelling, narrative play). Thus, purposeful interaction of formal and

non-formal education would appear ensuring complexity of the development of the geographic competence because the process of teaching would proceed in real-world environment and by applying interactive methods.

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# 6

Magdalena Banaszkiewicz

# Fun in the Power Plant. Edutainment in the Chernobyl Exclusion Zone Tourism

**Abstract:** In the recent years, there has been a significant rise in the popularity of tours organized to the Chernobyl Exclusion Zone (CEZ). A visit paid to the Zone usually exceeds the basic understanding of the Zone raised on stereotypes and opens a new horizon of deeper exploration of the complexity of this site. The aim of the chapter is to depict the educational potential of the tours organized to the Zone (not necessarily limiting themselves to the issues connected simply with the nuclear energy). The particular attention will be paid to the tension between education and entertaining that is considered to be a fundamental facet of visitors engagement in the intellectual process. Presentation of this topic will be based on a content analysis of the programs, participant observation and interviews with the organizers.

**Keywords:** heritage, entertainment, education, Chernobyl, tourism

## Introduction

In the recent years, there has been a rise in the popularity of tours organized to the Chernobyl Exclusion Zone (CEZ). The Zone is a displaced area under the strict control of the Ukrainian State responsible for its security. It is not only a site of memory, a physical space symbolizing a nodal event for Ukrainian memory and identity, but also a large nature reserve, where nature has been developing practically unhindered for over 30 years. While its presence in the global popular culture (i.e. video game "S.T.A.L.K.E.R.") strongly stimulates tourism imaginaries, the continued high levels of radioactivity of some areas and "post-apocalyptic" state of material object makes the experience of visiting the Zone both risky and exiting. A visit paid to the Zone usually exceeds the basic understanding of the Zone raised on stereotypes and opens a new horizon of deeper exploration of the complexity of this site. The aim of the chapter is to depict the educational potential of the tours organized to the Zone (not necessarily limiting themselves to the issues connected simply with the nuclear energy). The particular attention will be paid to the tension between education and entertaining that is considered to be a fundamental facet of visitors' engagement in the intellectual process.

## Tourism in the Chernobyl Exclusion Zone in Numbers and in Tourism Studies

The CEZ has been established in Ukraine in an area with a radius of approximately 30 kilometers from the power plant, the territory most affected by radioactive waste after the Chernobyl disaster in 1986. It is an area the population must not live, no economic activity would be carried out, and no food can be produced[1]. However, already in the 90s the first visitors started to appear in the Zone after obtaining a special permission from the Ukrainian government. The situation changed significantly in 2011 when the area was opened for official visitors under the regulations of the Ukrainian State Agency on Exclusion Zone Management. Since then, it is observed that there is a dynamic increase in the number of visitors to the CEZ: 8,000 tourists visited the Zone in 2010, almost 18,000 in 2013, and 36,000 in 2016 during the 30th anniversary of the disaster (almost 25,000 of whom were non-residents). In 2017, the number of visitors to the Zone reached 50,000 and 63 thousand in 2018. From January until the end of May 2019, the Zone was visited by as many tourists as in jubilee 2016 (almost 36 thousand)[2]. It is believed that the spring tourism boom, particularly visible for non-residents, is due to the huge popularity of the HBO series "Chernobyl", which not only gained critical acclaim, but also spectacular ratings (the fifth and final episode of the series was viewed by more than 2 million people in the US alone (Welsch, 2019) as well as audience support (on IMDb, over 280,000 users gave the show an average rating of 9.6 stars out of 10, making it the highest rated TV show on the platform (Stolworthy, 2019).

In recent years, a number of papers focusing on various aspects of visiting the CEZ have been published. One of the first researchers who focused on the process of ruination of the abandoned city of Pripayat was Paul Dobraszczyk (2010). In the consecutive year Goatcher and Brundsen (2011) presented their study on the emotional encounters of visits to the Zone and propose to use the

1 This area and its existing legal order are defined in the document: *'On the legal status of the territory which was contaminated by radioactive radiation as a result of the Chernobyl disaster* of 1991' (and subsequent changes), see Про правовий режим території, що зазнала радіоактивного забрудненння внаслідок Чорнобильської катастрофи, http://zakon0.rada.gov.ua/laws/show/791%D0%B0-12, Retrieved July. 10, 2019.

2 ЗОСТАННЯ КІЛЬКОСТІ КІЛЬКОСТІ ВІДВІДУВАЧІВ ЗОНИ ВІДЧУЖЕННЯ В РОЗРІЗІ 1 КВАРТАЛУ 2018–2019, https://cotiz.org.ua/novyny/stat1kv/, Retrieved July. 10, 2019.

term "sublime" in order to depict the special psychological state of person being in the Zone (Hannam and Yankowska, 2017). The specific character of the CEZ attracted attention of Philip Stone who, in his seminal paper published from 2013, compared the unique exclusiveness of the Zone's space to the Foucault's concept of heterotopia (Stone 2013). The environmental degradation of the CEZ served as an argument for Yankowska and Hannam (2014, p. 932) to label visits to the CEZ both as dark tourism and toxic tourism, stressing that this form of exploration "can provide a strong educational experience, raising awareness about the current environmental issues and the polluted environmental conditions around us" (Hannam and Yankowska, 2014, p. 937). However, the space of the Zone is being consequently mythologized particularly, thanks to the popular culture (Banaszkiewicz and Duda, 2019) and the visual representations easily accessible in virtuality (Banaszkiewicz and Skinner, forthcoming). Mediatization undoubtedly contributes to th treatement of the CEZ "an open-air museum of dark legends" (Afanasiev and Afanasieva, 2018, p. 38), where authenticity of physical space is the subject of performative interventions (Banaszkiewicz, 2018) but also a dissonant heritage that can stimulate intercultural dialogue (Banaszkiewicz 2020). The above studies do not exhaust the scope of issues and research problems related to the intensive process of the Zone touristification, on the one hand, and the representation of the Chernobyl disaster and the CEZ area in culture on the other. The two areas permeate each other, mutually stimulating strategies for the interpretation of the post-catastrophic heritage.

## Education and Entertainment in Tourism

An attempt of holistic explanation of the phenomenon of tourism can be reduced to two concepts. The first, recognizing tourism as a "secular pilgrimage" implies that a tourist is motivated by the search of meaning, discovering authenticity and transformation of a subject that offers different experience, seeing them in the search for pleasure and entertainment, thus allowing tourists detachment from everyday worries and responsibilities (Boorstin, 1977 Pfaffenberger 1983). The concept reaches into the roots of the humanistic reflection on the condition of man, perceived as a working being. As Władysław Okoń wrote, referring to Aristotle: "Fun is a consequence of work understood as fatigue. Where is work, there must be fun, because tiredness requires rest [. . .]" (Okoń, 1995, 60). Leisure time intended even for travel stands in opposition to economic activity and, therefore, is to give pleasure impossible to get while working, identified with the duty, seriousness and responsibility. According to Johann Huizinga

(1944), the author of a classic view of man as *homo ludens* – playful creature – this "unseriousness", which is a free action, is a quintessence of fun.

However, while according to Huizinga, fun can be a deadly serious matter and is simply a property of culture that cannot be assessed as good or bad, entertainment, that is simply just fun, is a product in consumer culture, and is threat to adults getting infantile of the scale on alarming proportions. James E. Combs (2010) and Neil Postman (2000), we are entering a new phase in human history, permeated by fun to such an extent that it can be described as a world of fun. Entertainment is a distinctive form of mass culture, which, at the same time, is a consumer culture. Therefore, there is no consumer culture without entertainment. Consequently, tourists are hedonistically oriented consumers, desirous for still new experience stimulating their emotions (Bauman 1996, Salazar 2010).

Tourism based on products that give pleasure and relaxation, referred to as 3S (sun, sea, sand), has become a designate of the most popular type of mass travels, i.e., rest at resorts in warm countries. However, with the tremendous development of tourism over the last 25 years, there has occurred, which was a part of global consumption trends, the needs of tourists, and consequently change in offers. Shifting significance from product (possessions) to experience (collecting experience) (Pine & Gilmore 1999), which has become a pillar of a cathedra of consumerism of the 21st century, found its reflection in travelling (Urry & Larsen 2011). In many cases, the 3S has been replaced by 3E (entertainment, education, excitement). Moving away from mass tourism based on environmental values, and consequently turning to individual tourism based on active involvement from a tourist, as well as increasing share of tourism product of cultural tourism category, is a characteristic trend observed globally in the recent years.

Entertainment has not been abandoned, but was put in a triad along with education, i.e., cognitive element and excitement, i.e. "experience", strong and positive emotional stimulus (Robinson & Picard 2016). In relation to the increasingly common educational strategy of gamification, tourism also recognizes elements characteristic of the game world, and which are referred to as 3F (fun, friends, feedback). It is not so much fun as entertainment among friends aimed at achieving further goals, which are counted and recorded in the form of feedback (e.g. points, badges, tokens) that becomes the axis of creating tourist programs, especially for young people. Not looking far, such an approach has its roots in the scout movement, where the basis of upbringing is action. The involvement of tourists in the process of experiencing travel more than just passive gaze can be referred to as a theoretical framework for the concepts of

experience economy (Pine & Gilmore 1999, Urry & Larsen 2011) that puts in the center of exchange not products or services but experiences.

Highlighting the correlation between effectiveness of education and presence of elements of entertainment in cognitive process is by no means a new phenomenon, however, growing in importance in recent decades, at heritage sites that are tailored to tourists' needs for entertainment. It is worth to remember, that not only scenarios of exhibitions or "ludic" projects translate into the effectiveness of educational process. The spectrum of motivation is its indispensable element as it guides a recipient (visitor, spectator, tourist). According to research cited by John H. Falk and Lynn D. Dierking (2010, 79), better cognitive results are achieved, when a museum visitor has a high level of motivation: "As it would be expected, individuals voicing a strong educational motivation demonstrated significantly greater learning than did those expressing a low educational motivation. However, less expected, a similar relationship was found among those individuals voicing strong entertainment motivations. These significant differences were independent of the individual's expressed educational motivations." As it turns out, a pro-entertainment attitude results in better educational outcomes. When presenting a dissonant culture, it is particularly challenging to include solutions that allow to enjoy the fun. This is due to the fact that such heritage is not subject to harmonious interpretation. Ambivalence related to its perception requires people managing the heritage to be particularly delicate and intuition driven so that not to present a one-sided, subjective and over-simplified narrative of the past, in the name of striving for making heritage experience enjoyable.

## Educational Nuclear Tourism in the CEZ

Currently, the trips to CEZ are organized by various tourist entities: both Ukrainian and foreign companies, mainly using the intermediation of local tour operators. It is hard to deny that such a dynamically developing Chernobyl tourism is already more and more mass in nature, which is supported by the Agency's recent activities (e.g. simplifications in the entry procedure, introduction of electronic tickets, adjustment of infrastructure to the needs of tourists) as well as unambiguous declarations of the new central authorities of Ukraine, which perceive the Zone as a tourist attraction of great potential[3]. Due to the

3 From the formal point of view, tourism activity as an economic activity for many years has been prohibited in the Zone. President Volodymyr Zelenskyon 10th July 2019 during the ceremony of handing over to Ukraine the construction protecting

needs of the market, the offer of tour operators is becoming more and more diversified. It is based, of course, on one-day excursions, the main point of which is a visit to Pripyat, but what is interesting, the biggest organizers of trips to the Zone try to shape their image as active heritage stakeholders and not only commercially oriented businesses. Naturally, a narrative about "the mission" can be an effective marketing tool, but the involvement in other projects related to the dissemination of knowledge about the Chernobyl brings objective educational fruits. The CHERNOBYLwel.com office cooperates with the National Museum of Chernobyl in Kiev and organizes the Chernobyling Festival[4]. Tour operators also organize graffiti cleaning and garbage collection actions in the Zone.

Educational profile of the activity is characteristic primarily for the enterprise called The Chornobyl Tour, also known as the Chernobyl Tour operating on the market since 2008. The name of this organizer appears in two language versions – Ukrainian language "Chornobyl Tour" (official name of the company) and English language "Chernobyl Tour" (used as a domain name and in promotional materials addressed to foreign tourists). This is an interesting example of how post-colonial geopolitics translates into tourism. The Anglophone world knows Chernobyl from the Russian language version ("Chernobyl"), not the Ukrainian ("Chornobyl") or Belarusian ("Kharnobyl"). Hence, for foreign visitors, this is the name of the company. Its co-founder and a person responsible for the scientific layer of the tour, including the training of guides, is Sergii Mirnyi – one of the liquidators of the consequences of the accident at the power plant, often appearing on the international arena as an

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the old Sarcophagus over the 4th reactor of the so-called New Ark, he signed a decree which is to be the beginning of "the transformation of the exclusion zone into one of the points of development of the new Ukraine"

https://www.president.gov.ua/en/news/glava-derzhavi-pidpisav-ukaz-shodo-rozvitku-chornobilskoyi-z-56321 During his visit, the President called for an end to the corruption and bans on tourists and for the isolation zone to be turned into a future magnet for tourists and scientists.

4 Chernobyling is a three-day festival organized for the first time in 2017 in Slavutych. The idea is to bring Chernobyl issues closer to young people through concerts, seminars, meetings with interesting people and sightseeing (and also to revitalize the cultural life of the city). As the organizers declare, the income from the event is intended for self-residents. The official language of the festival is English. The second edition of the festival in 2018 is to be held in Kiev. See Chernobyling, https://www.facebook.com/Chernobyling.festival/

expert in Chernobyl matters[5]. As S. Mirnyi argues: "Back then we fought with physical, radiation contamination, and now we eliminate a different, informational kind: contamination of human brains by misconceptions and outright myths. In the Zone, radiation contamination is largely defeated, for it has been localized and REDUCED MORE THAN MILLION TIMES as compared with the first days of the disaster. But in human minds, in their thoughts, perception and imagination it continues to persist as "deadly dangerous" – as if the cleanup was never done. This causes enormous harm to the health and life of people and whole countries. So, in order to make radiation decontamination truly efficient – as it has turned out – one needs complement it with one more, informational cleanup. And, frankly, each time, when in the end of the day I with the group leave the Zone, I feel something similar to what I felt, driving out the column of radiation recon armiks back in 1986: that after my shift a bit more people have become safer, and the world slightly different – a bit cleaner and better a place." ( Chernobyl Tour – Mirnyi, https://chernobyl-tour.com/sergii_mirnyi_en.html)

Mirnyi postulates that the commercial activities of the company should be treated only as one of the forms of combating "information contamination". (Chernobyl Tour - About, https://www.chernobyl-tour.com/about_us.html), which he repeatedly emphasizes in his interviews[6]. The Chornobyl Tour includes a research department, whose work is directly supervised by Mirnyi himself. His activity consists mainly in close cooperation with the media in the field of Chernobyl issues, and recently also in lobbying the political and social environment for the inclusion of the material heritage of the Zone (mainly the selected buildings of the Pripyat) on the UNESCO World Heritage List. The educational dimension is also to be characterized by trips to CEZ organized by

5 Sergii Mirnyi was a commander of radiation reconnaissance platoon in Chernobyl in 1986. Accept his involvelment in the activities of the Chornobyl Tour as its scientific advisor, he is a writer and scriptwriter, and an internationally known expert in the Chernobyl Disaster and mitigation of ecological-social disasters. He is an author of books "Worse than radiation" and "7 odd Chernobyl stories" (Budapest: Bogar Kiado, 2001), "Chernobyl liquidators health as a psycho-social trauma" (Budapest: Bogar Kiado, 2001) and several dozen artistic and scientific publications, presentations at international conferences.

6 The following section on Chernobyl Tour activities is based on material collected from the 2017–2019 grant field research in Kiev and CEZ, in particular the in-depth interviews with Sergii Mirnyi Yaroslav Yaroslav Yemelianenko, Ann Merrill, Svitlana Priadko conducted in February 2019.

Chernobyl Tour. For this reason, every tour guide of the Chernobyl Tour Zion is bound by labour standards that can even be compared to corporate standards. After relevant training, a candidate for a guide takes an internal exam, which only entitles him to give a tour of the company's groups. What is more, the guides are obliged to use the substantive elaboration (type of script/trip scenario) and their work is checked by other guides and ghost clients.

All these measures are aimed at maintaining a high quality of service, although they also impose certain restrictions on the guides working for the company. In addition to the "standard" one-day program, which in its scope is relatively similar to the programs of competitors, Chernobyl Tour offers a deeper exploration program that can last from one to several days and includes places less obvious (e.g. fish and rodent scientific experimental base, Yaniv railway station, Paryshiv village, meeting with selfsettlers). In addition, interested parties may also book a private tour of the Chernobyl nuclear power plant (that includes construction site of the new confinement "Arch", mockup hall at the Administrative and Service Complex (ASC-1) of the PDO, "golden corridor" extending through the building of the PDO, the control panel of the reactor, turbine hall, reactor hall, memorial to Valery Khodemchuk, buried under the ruins of the reactor and the room with the main circulation pumps).

In search of new customers, Chernobyl Tour has also created an unusual, as for Ukrainian conditions, offer of study trips of strictly educational character. It is aimed primarily at foreign visitors recruited from the academic community. In order to develop educational programs, Mirnyi has partnered with Ann Merill, a US-based specialist in organizing international educational programs, coordinating academic projects, and with extensive experience in NGO's in the socioeconomic environment of Eastern Europe. The result of this cooperation is a program of specialist thematic excursions, which can be attended mainly by foreign students, mainly from science faculties. In 2018 the Chernobyl Tour organized visits to the Zone for about 85 students and professors from the USA, UK, Azerbaijan, Norway, the Netherlands, South Korea, Germany, and Japan. Their interests ranged from engineering (including nuclear, industrial, materials science), radioecology and radiobiology, social and ecological resilience, and "dark" tourism. Interestingly, the study groups are not limited to nuclear exploration, but also present lesser-known themes such as the heritage of WWII and the Cold War.

At this point it is worth emphasizing the importance of research department in the process of creating new tourist products. A good example is the latest thematic excursion organized by Chernobyl Tour in a weekly cycle since June 2019. The "HBO Chernobyl" TOUR series is Chernobyl's direct response

to the dizzying popularity of the series "Chernobyl" and aims to "revealing to the secrets and real stories of the events that occurred". (https://chernobyl-tour.com/serial_chernobyl_hbo_tour_ukraine_en.html). During the tour, both "must see" points, which did not have much meaning for the series itself, but are the Amusement Park of Prypiat with the world-famous Ferris wheel or the lunch of power plant employees in the canteen of the Chernobyl Nuclear Power Plant, as well as authentic spaces were taken into account, which are the location of the series of events (the basement of the Chernobyl nuclear power plant, in which the liquidation headquarters was located in the first days after the explosion of the fourth power unit or, the fire department from which the first firefighters left for the scene, the medical unit of the city of Pripyat, which received the first victims, the legendary bridge of Pripyat town). There will also be an "entertainment" point (a ride in an armored patrol vehicle, in which the liquidators in 1986 made a radiation reconnaissance, making the first radiation contamination maps), but also a cognition of "the real stories of people whose characters were reflected at the series" I as promised by the organizers "some of them you can even meet in person".

What is important, before the new program was added to the offer, it was preceded by analytical work on the compatibility of the series with reality and social consultations with representatives of the Kyiv magistrate, among others. At this stage, a meeting with witnesses of the 1986 events, open to the general public, was particularly important, thanks to the personal contacts of Sergei Mirnyi.[7] Of course, there is no doubt that such events contribute to the increase of media recognition of the agency itself (which, shortly after the development of the new route, organized a special study tour for media representatives). At the same time, the use of the potential of popular culture for edutainment seems to be a very effective tool, as it reaches out to people who would most likely not benefit from a more scientific offer, as in the case of educational programs.

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7 During a meeting held on June 5, 2019, the newly opened Chernobyl Hub, a club in the courtyard of the Chernobyl Tour office in Kiev, the gathered guests watched the last episode of the HBO series together and then took part in a discussion with guests: Sergei Paryszyn, who participated in the first meeting of the crisis staff in the bunker under the power plant management building, Alexei Breus – the operator of the fourth block, who began his shift on April 26, 1986. at 7 a.m., Alexei Ananenko – participant of the diving mission in flooded rooms under the reactor and Siergiey Mirnyi. The report from the event can be viewed at the link: Учасники аварії на ЧАЕС обговорють серіал CHERNOBYL HBO, https://www.youtube.com/watch?time_continue=9&v=2DR8QqnuzZE,

Regardless of the subject matter and length of the trip, Chernobyl Tour focuses on combining elements of education and entertainment, both at the level of content and in the realization of the programs themselves: knowledge is conveyed through anecdotes, universalization, and analogies, and guiding strategies are based on intensive dialogue with the audience, performative involvement of the visitors, provoking them to reflect and interpret themselves.

Educational trips for Chernobyl Tour are only a supplement to the basic offer, which is well characterized by the aforementioned acronym 3F. In turn, the Polish organizer of the "Zero Zone", which will be presented in this chapter as the second case study, oscillates much more on the border of science than entertainment. From the formal point of view, the Zero Zone can be classified as a tourism organiser (it has a relevant legal entity), although the website repeatedly emphasizes the untypical nature of the offer, created by a group of enthusiasts, former students of the Warsaw University of Technology, who in 2007 went to Chernobyl for the first time. After establishing cooperation with the Polish Nucleonic Society, they started to organize trips regularly and are currently the oldest Polish organizer of trips to CEZ. The main pilot and guide in the Zone is Dr. Marek Rabiński, a member of the Polish Nucleonic Society and an employee of the National Research Centre in Świerk, although the trips often involve other employees of the National Centre for Nuclear Research and people professionally professionally or amateurishly interested in nuclear energy. The local guide Sergey Akulinin, a former operator of reactor turbine no. 2 in Chernobyl Nuclear Power Plant and a participant in the accident liquidation action, is a permanent collaborator of the Zero Zone on the spot. As the tour operators emphasize, referring to the "scientific" profile of the tour guides, "this does not mean that the trip is only for scientists. The trip is for everyone (with small restrictions). The participation of researchers ensures that the trip is safe for health". (Zero Zone, https://strefazero.org/index.php?id=6#). The organizers, being aware that too much "science" can be a deterrent, try to cut the program so that its entertainment elements balance the educational element.

As in the case of thematic trips organized by Chernobyl Tour, Zero Zone trips are not one-day trips – participants spend an average of 2–3 days in CEZ and the program is much more flexible than in the case of "standard" trips. In the tab presenting the specificity of trips, very strongly (both verbally and visually, as can be seen in the attached illustration), highlights the difference between the "The Zero Zone" and other tour operators consisting in greater involvement of the tourist himself (see Fig. 1):


**Fig. 1:** Extract from the description of the trip from the "Zero Zone" website (screenshot), source: Zero Zone, https://strefazero.org/?id=104&ArticleId=145, date of access: 16.07.2019

The organizers strongly dissociate themselves from the stereotypical image of a tourist trip: "With us you will definitely see more and feel the atmosphere that constantly accompanies today's employees of the closed Chernobyl zone. On our tour, you are an explorer, not a tourist."

Indeed, the program of the expedition is a framework and the organizers give a lot of freedom to the participants of the trip, not only by declaring on the website that "In Pripyat the participants receive from us maps of the city and explore what they want. If the situation does not require us to do so, we do not force anyone to walk in a group". (Zero Zone, https://strefazero.org/?id=104&ArticleId=145, access: 16.07.2019) Thanks to good agreements with local guides and Agency staff, the Zero Zone actually offers more exploration opportunities. The first difference between the basic program of a one-day trip organized by a mass organizer and the program of a standard group of Zero Zone (trips) is logistics – Zero Zone groups live in Slavutych and enter the Zone area by an extraterritorial employee train. During the three days of the visit, the group explores, among others V and VI power plant block and a mink research farm, St. Ilia's Church from 1789, barge dump, cemetery of old fortresses, a monument to partisans from World War II, Yanov station, and Burakivka equipment dump. As you can see, the program definitely extends the list of attractions in relation to what a one-day tourist visits, including also those places that are not directly related to the disaster itself, but present the heritage of Polesie before the outbreak.

In addition to daily exploration of the abandoned buildings of the Pripyat on your own, there is a possibility of visiting the interior of the Chernobyl Nuclear Power Plant, although admission to it is additionally paid from April 2018. The organizers of the trips try to enter the current of popularization of knowledge at all costs. A sightseeing program combining elements of scientific cognition (such as detailed mini lectures on the functioning of power plants or nuclear power engineering) and entertainment (urbex character of cognition of the Pripyat) is the implementation of this strategy. It is important, however, that

the "Zero Zone" also tries to shape its image on this basis, cooperating with the creators of YouTube (MocnyVlog, Tube Riders, Urbex History, Potato) and Polish media giants (TVN, Onet, TVP). In the spring of 2019 she organized a trip with two famous YouTubers, Krzysztof Gonciarz and the creator of "Uwaga Naukowy Bełkot" ("Attention Scientific Gibberish"), which resulted in a documentary miniseries about the Zone (Chernobyl 2019, https://www.youtube.com/playlist?list=PLRIPPC8uohcdT1a-DW7pH4lWPTELCdeov) and two episodes of popular science blog (https://www.youtube.com/watch?v=BmPry7Gr0-M). Both the forum and the fanpage on Facebook "Zero Zone" have a mixed character combining historical facts, facts about nuclear power, news from the Zone, and information about trips to the Zone.

## Summary and Conclusions

The idea behind this chapter was to present an educational offer of tour operators specializing in creating trips to the Chernobyl Exclusion Zone. There is no doubt that the Zone has become a popular tourist attraction in recent years. Regardless of its formal status, the interest of tourists, not only from year to year, but also from month to month, is growing, which makes both the space of the Exclusion Zone undergo changes and the range of tourism organizers' offer changes. On the one hand, the growing range of programs is intended to respond to the heterogeneous needs of tourists, and on the other hand, the creation of new products stimulates the number and profile of visitors. In the analysis of the case studies cited above, it was attempted to demonstrate that the sightseeing programs combine elements of education and entertainment to a varying degree. Firstly, it is a consequence of general trends observed in tourism (regardless of whether they are acronym 3E or 3F, the element of fun/entertainment is inalienable), secondly, the tourist potential of the Zone itself, whose heritage is not only limited to post-catastrophic value. The fact that both factors, or both sides of the same coin, i.e., supply and demand, are taken into account allows a better understanding of the Chernobyl Exclusion Zone tourism phenomenon. The nuclear issue, although it seems to be the basic thematic axis of the trip to the Zone, is one of many threads that can be explored in its space. In-situ experience offers great opportunities for interpretation with regard to the issues of nuclear energy, so it can be assumed that programs profiled in terms of nuclear tourism will continue to be developed.

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