ATINER's Conference Paper Proceedings Series
STEAM2018-0107
Athens, 2 October 2018

STEM Teaching and Learning - A Journey from Virtual to Real World

Elitsa Peltekova and Eliza Stefanova

Athens Institute for Education and Research
8 Valaoritou Street, Kolonaki, 10683 Athens, Greece

ATINER's Conference Paper Proceedings Series
STEAM2018-0107
Athens, 2 October 2018
ISSN: 2529-167X

Elitsa Peltekova, PhD Student, Sofia University "St. Kliment Ohridski", Bulgaria
Eliza Stefanova, Associate Professor, Sofia University "St. Kliment Ohridski", Bulgaria

STEM Teaching and Learning - A Journey from Virtual to Real World

ABSTRACT

The paper discuses virtual reality (VR) enhanced teaching in Science, Technology, Engineering and Mathematics (STEM) domain. Study encompasses development and testing of the VR enhanced (by VR device, mobile phone and VR mobile application) scenario for in-service educators which apply inquiry-based learning (IBL) approach. A scenario with this idea is designed in frame of Erasmus+ project "Enhancing Learning in Teaching via e-inquiries" (ELITe). Developed by Bulgarian team scenario is called "Dream" and reality scenario is about Physics - Astronomy in particular. Its testing with educators in frame Sofia University "St. Kliment Ohridski" research science fund project N80-10-90/19.04.2018 aims to get to know STEM teachers with the new existing technologies which can enrich their teaching and learning process. Also how they can develop by themselves a design of "non-traditional" training (by using virtual reality technology or some other Information and Communication Technologies /ICT/) and "reality" (real places for educational visits) and how both of them can improve learning process, increasing students' performance on the STEM disciplines is another important goal. Generally, the study examines how the "reality" in STEM discipline teaching could be improved by VR.

Keywords: STEM, Virtual reality, VR Scenario, Inquiry-Based Learning, ICT.

Acknowledgments: This research is partially funded by Sofia University "St. Kliment Ohridski" research science fund project N80-10-90/19.04.2018 "Use of high tech in implementation of inquiry-based learning in STEM subjects in secondary school"; ELITe project (Enhancing Learning In Teaching via e-inquiries, EC-Erasmus+ project 2016-1-EL01-KA201-023647); and Faculty of Mathematics and Informatics, Sofia University "St. Kliment Ohridski".

Introduction

STEM subjects often are mentioned as difficult for students. Facing these problems, teachers aim should be focused on students' understanding of subjects' material rather than only memorizing facts that will be forgotten after the test at school. Educators are in need of new approaches for training which does not bother contemporary young people, but on the contrary, it is interesting and intriguing for them. In addition, teachers now that students expect personalized education, tailored to the learner. Moreover, knowledge should be acquired at different speed, volume of theory to be taught to be reduced and accent on experiments, hands-on activities and exercises, especially in STEM subjects, to be placed. Young people ask themselves when certain information is going to be put into practice, and in order to answer them, it is needed to be demonstrated to them. Many students would take any opportunity not to attend school, not because they did not want to study, but because the learning process not interest them to such an extent that they already associate the word "learning" with "torture". Every student would desire to amass knowledge as long as the educational system allows him or her to realize this. Educational change is required in order to focus on the development of thinking and creativity which are needs of the present and the future.

This study aims to answer the research question whether inquiry-based learning combined with traditional teaching approach and technologies (mobile devices, mobile devices with virtual reality devices, VR apps) can help the educators (teachers in Bulgarian schools) to raise learners' interest to STEM subjects and accordingly to improve their achievements.

Related Works

Educational fields of science, technology, engineering, and mathematics, also as STEM, have received growing attention during the past decade. There are number of reasons (Danish Technological Institute, 2016), some of that are:

- STEM skills are associated with advanced technical skills, which are seen as strong drivers for technology and knowledge-driven growth and productivity gains in high-tech sectors, including ICT services.
- Due to demographic developments, there will be a high replacement demand for high-skilled professionals working in STEM-related occupations in the coming years. This has led to concerns that Europe could lack an adequate supply of STEM skills to enable its future economic development (European Parliament - Committee on Employment and Social Affairs, 2013).

Some researchers and practitioners make efforts for changing education by mean of VR. Samples of such experiments with VR technology integration in education is developed by Czech Technical University, Prague, Czech Republic.

Department of Computer Graphics and Interaction (DCGI), Faculty of Electrical Engineering of the Czech Technical University in Prague (CTU) which has virtual reality laboratory (VRLab) participates in two interesting research projects connected with VR (Roman Berka, Jiri Bittner, & Pavel Slavik, 2011):

- VRUT: The VRUT (Virtual Reality Universal Toolkit) project is developed in cooperation with the Skoda-Auto company ("ŠKODA Mobile Apps," 2018). It aims at the development of various tools for high quality stereoscopic presentations and evaluations of the virtual car prototypes.
- VERITAS: The VERITAS project aims to develop, validate and assess tools for built-in accessibility support at all stages of product development, including specification, design, development and testing. The goal is to introduce simulation based and virtual reality testing at all stages of assistive technologies product design and development into various applications that handicapped users can use.

Recently this year (May 2018) in CTU was newly opened Virtual reality classroom ("VR Classroom in CTU," 2018), which is equipped with portable notebooks ACER Predator Helios 300 with Windows 10 and ACER Windows Mixed Reality Headsets. VR changes the methods of work and learning and try to improve for better the quality of life. VR is helping to get students involved more and enables them to remember more things and they find learning in VR attractive. In cooperation with Microsoft ("Windows Mixed Reality headsets," 2018), ACER helped CTU to equip the VR classroom with 15 headsets.

Figure 1. *VR Classrom in CTU*

Source: ("VR Classroom in CTU," 2018).

The aim of this VR classroom is to introduce and show solutions in practice both to end users as well as to students and teachers. VR is enriching education and enrichment is very intensive, it is very useful for architect and designers, there are large industrial companies which do not develop prototypes because they prefer designing them in VR, and then, let's say about 20% of the development is carried out on physical level, which means that companies can save large amounts of their investments. Pantelidis (1995) gives the following reasons to use virtual reality in education (Pantelidis, 2010):

- Virtual reality provides new forms and methods of visualization; it provides an alternate method for presentation of material. In some instances, VR can more accurately illustrate some features, processes, and so forth than by other means, allowing extreme close-up examination of an object, observation from a great distance, and observation and examination of areas and events unavailable by other means.
- Virtual reality motivates students. It requires interaction and encourages active participation rather than passivity.
- Virtual reality allows the learner to proceed through an experience during a broad time period not fixed by a regular class schedule, at their own pace. It allows the disabled to participate in an experiment or learning environment when they cannot do so otherwise. It transcends language barriers. VR with text access provides equal opportunity for communication with students in other cultures and allows the student to take on the role of a person in different cultures.

In our understanding, the availability of the technology is not enough for effective education. In order to apply VR in STEM education, it is important to identify when and how to integrate it, as well as to train teaches how to do it themselves. That is the reason we consider to design, develop and implement an educational VR enhanced STEM scenario. It illustrates to the teachers an approach to use the power of VR for topics in which it is not possible in other way students to be involve in reality – for places where students could not make a journey there to learn, to explore, to experiment: because it is dangerous – e.g. volcanos, ocean, universe; because it is impossible – e.g. in human body; because it is imaginative – e.g. innovative architecture. That is way we offer an approach and sample scenario for training teachers how they to design for their students a journey from virtual to real world.

Proposed Method

In this section we discuss the design and implementation of scenario "Dream" and reality.

Scenario Design

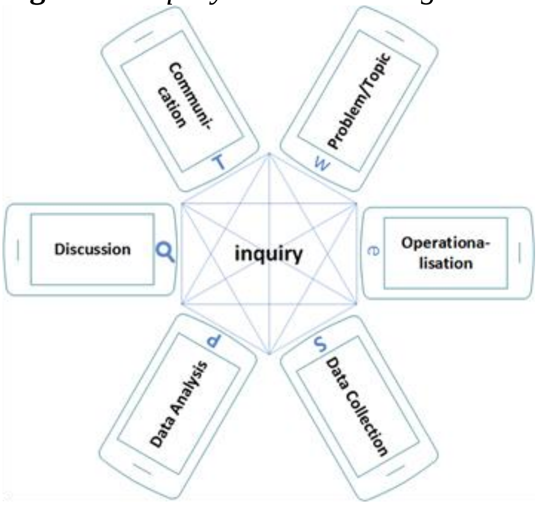
Scenario uses ELITe project ("ELITe," 2018) template specially designed and based on six phase inquiry-based model.

Inquiry-based learning Model

"Dream" and reality scenario is based on weSPOT inquiry-based model (Figure 1) which defines six key phases, presenting stages of a scientific research process: Problem/Topic phase where the scientific statement is defined;

Operationalisation phase - the research methods are planned; Data Collection phase - the facts and evidences proving the hypothesis are gathered; Data Analysis phase - the collected data are surveyed; Discussion/Interpretation phase - the results of the research are debated, and Communication phase - the final results are shared with all interested communities (Miteva, D., Peltekova, E., & Stefanova, E., 2014).

Figure 2. *Inquiry-based Learning Model*



Source: weSPOT Project (Miteva, D. et al., 2014).

VR Equipment

VR technology in our scenario includes use of two free astronomy mobile VR application (app) which we run on Android smartphone. We also use one of the applications (apps) with GoogleCardboard Glasses ("Google Cardboard – Google VR," n.d.). Apps and VR device choice are based on the fact both are free and offer good quality service for the purpose of our study.

Online IBL Platform

DojoIBL is an online platform for e-inquiries which follows IBL model is especially designed for the needs of ELITe project which aims to serve teachers. There is available our scenario.

Senario's Sites

Senario's sites or physical locations where the different stages of the scenario are performed. These are computer lab in Faculty of Mathematics and Informatics, Sofia University "St. Kliment Ohridski" and the Astronomical Observatory at Sofia University "St. Kliment Ohridski".

"Dream" and Reality Scenario

In this section very thoroughly is described the scenario "Dream" and Reality which is main focus of this article. This specific ELITe scenario deals with:

- Promotion the variety of existing opportunities to combine "dreams" (online tools, virtual reality, augmented reality and others) and "reality" (real places for educational visits) and how both of them can enrich the learning process, increasing students' performance on the STEM disciplines.
- Understand existing and new technologies and how they can enhance educational process.
- Leave the classroom (outdoor lessons) and organize visits to scientific and research institutions where certain research experiments and demonstrations can take place.
- Interdisciplinary training will be an outcome of the teachers' teamwork. Application of the IBL model to study nature requires more specific teachers' competences.
- Challenges that teachers have to solve when they plan to organize outdoor lessons. Problems encountered in implementing technology-enhanced learning and in using new technologies in learning.
- Advantages and disadvantages for learners and trainers in the "dream" and "reality" training scenarios.

This scenario is planned to be conducted as a teacher training course.

Requirements

There are a few requirements for the teachers to participate in the training ("ELITe's Bulgarian Scenarios," 2016):

- activities - participate in "Brainstorming" and discussions and activity in the electronic system
- design of training (predefined criteria)
- presentation of the developed work during the training

Aims of the Training

Competencies development:

- study and application of regulations;
- performing pedagogical research;
- designing a "non-traditional" training.

Improvement of skills for:

- planning, organizing and evaluating students' activities;
- awareness and use of new technologies, apply them in class, i.e.; conducting technology-enhanced teaching/learning.

Results from the Training

General goal of the ELITe project is to support teachers' professional learning for competence development, aiming specifically in-service educators in the STEM domain. By this scenario we aim some of the following results:

- development of a set of documentation for students' field trips or visits to science places (observatory, planetarium, etc.);
- developing a set of documentation for the use of mobile devices, VR devices or some other devices in a class with educational purpose for performing a lesson (or a series of lessons) on a subject related to objects observation, phenomena that can hardly can be observed in class;
- preparing a scenario plan for conducting a lesson in a class which is technology-enhanced. Choice and description of required technologies (minimum technical requirements), need of availability of additional devices (e.g. VR devices as VR glasses).

Scenario Workflow

Scenario workflow consists of six phases where each phase has between five to nine subphases. Each subphase has up to three characteristics – activity, tools and learning resources. Full list of phases and sub phases are given below in Table 1.

Table 1. *Scenario Workflow*

Subphase	Activity	Tools	Learning Resources
Phase 1: Problem / topic			**Duration:** **Phase 1** – 4 learning hours
1.1. Motivation	Task: Look for your zodiacal constellation on the sky map. Describe where it is located, at what time of the year it is visible to us. Can you show it in the sky? Organize a visit to an observatory where, with the help of a telescope, you can observe the stars in "reality". Set the GPS coordinates of the observatory and set a meeting time there.	Individual work ● During the observation, the whole group is divided on two. On the half group the eyes are tied with a scarf/bandage, and on the other half -not. Trainees work in pairs - one with tied eyes and the other – not. The person without a bandage needs to explain enough clearly what is visible on the sky (in the phone application, with the virtual reality glasses or with the telescope). Then the roles are exchanged.	Software/Application for observation of the stars and constellations (and in particular zodiac constellations). Use virtual reality devices (mobile phone and VR glasses) to observe constellations. A good internet connection is required if possible or an option for using the application offline. Application to find an object by defined GPS coordinates. Telescope in an observatory or elsewhere. Printed / Paper Star Cards with Zodiac Constellations.
1.2. Introduction to the topic	Group discussions: ● Teachers of the same subject from different schools ● Teachers of different subjects from the same school	Presentation of the Zodiac constellations by groups. The groups are formed by people with the same zodiacal sign. Questions: ● When do the descriptions of the zodiac constellations arise? ● Why and when do people describe / create the zodiacal signs? ● Why are the zodiacal signs exciting? ● What kind of scenario will best present the topic: outside the classroom, in the classroom supported by technologies or a combined lesson ● how to explain the reality of a pupil who cannot see it	It is possible to present to trainees videos, audio story projections and subtitles.
1.3. Specify the context	Formulating the problem situation/hypothesis	Discussion: • Is it possible that the things that pupils study by descriptions and explanations can be seen in the real world? • Can this observation be simulated in a way to leave a feeling of real experience? • How do we teach STEM at school? In the classroom or in real life? • Do our pupils need to see in "reality"	

Subphase	Activity	Tools	Learning Resources
		the things that are written in the textbook? • Is it important to allow students to touch real equipment (for example, for observation)? How would this increase the learning effect? • Why are avoided the classes outside the class, or outside the school/outside the living place? What are the problems for teachers to organize it? • Would students be happy to participate in outdoor lessons or lessons outside the living place? What technics could be used to motivate them? • Would students be more interested in the subject and will they have more respect for the teacher if he uses new technologies in class?	
1.4. Existing knowledge	Brainstorming	Mind Map: Aspects for consideration when we organize outdoor learning activities and want to use mobile applications in combination with virtual reality devices	Hints: • Legislation, related to out of the school students' activities organization • Students' age • Curricula • Interdisciplinary relationships • Conditions for working outside • Safety • Internet connectivity • Mobile devices with minimum technical requirements
1.5. Reflection	Understanding the different aspects that need to be considered when organizing outdoor training and learning supported by virtual reality technologies.	Reflection	Hints: • Is it actually so difficult to organize outdoor learning activity? • What is the most challenging moment? • Could you attract other teachers with whom to form a team? • Is it realistic to prepare all of the documents together?
Phase 2: Operationalization			**Duration** **Phase 2** – 4 learning hours

Subphase	Activity	Tools	Learning Resources
2.1. Indicators for successful outdoor learning design	Preparation of TODO list	Notes Questions: ● Do we need a special equipment – to buy it or to rent it? ● Is there a ban on using mobile devices in the school? ● If we want to visit an observatory - is there one in our city or should we have to organize a trip? ● What is the schedule of holidays and leisure time for organizing such training? ● How to organize training for children with SEN	Hints: • Required documentation for organizing outdoor activities • General topic of the educational project • List of disciplines, related to the topic • learning goals, outcomes and activities – inquiry-based and creativity-based ones • Expected final products • Achievements' assessment
2.2. Possible general topics of outdoor learning	Brainstorming	Mind map: Dream and reality – virtual and real;	Hints (if needed) • advantages of using real stargazing equipment • advantage of virtual reality technologies
2.3. Forming teams	By subjects or by schools	Mind map: Advantages in learning in "dream" and in "reality". Formed teams of 3-4 teachers with common interests	
2.4. "In the shoes of students" - Outdoor game, team building	Each team receives a map of the region with key places marked. The task is to collect artefacts placed in each key point, which to use for solving problem or a puzzle (according to the season and area). Ideas: • Decoding a message, encoded by natural objects • Collecting tagged natural object which to use for creating a poster with team message • Collecting natural objects and describe their origin– tree leafs → identifying the tree, classification,… • Taking photos of given natural objects – mushroom, moss, bird, bush, etc. in order to obtain a	Map, notes, digital cameras, audio recorder, mobile phone,…	Prepared in advance maps, artefacts, tasks

Subphase	Activity	Tools	Learning Resources
	picture of biodiversity • Discovering of hidden pieces of puzzle and collecting them but so as to preserve the nature		
2.5. Good practices	The trainees are familiarized with scenario descriptions of similar trainings	Files, storytelling by experienced teacher	Articles, video, meeting with experienced teacher
2.6. Planning the methods for work with students	In teams: formulating a hypothesis about appropriate activities corresponding to the general topic chosen and students age	Hypothesis	
2.7. Planning the place and season for outdoor training	In teams: choosing the place and the technologies that will support the learning process, time to conduct the training according to the learning objectives, planned activities, age of the students and the training schedule.	Notes	Literature on the topic, conversation with an experienced colleague, Internet and online resources
2.8. Ethical issues	**Discussion** about potential treads of exclusion of students – due to healthy problems, rejection by parents, etc. Looking for possibilities for inclusion – through distance participation by the aid of mobiles, etc. How to include children with Special Educational Needs (SEN) and disabled children (blind, deaf, physically disabled) • How should everyone, including children with SEN, be included in the IBL project?	Discussion	Literature on the topic, conversation with an experienced colleague and / or a colleague specialized in working with children with SEN and children with disabilities (blind, deaf, physically disabled)
2.9. Methodology	Description of needed information to organize outdoor training: • Required documents for organizing out of the school activities • Survey of available accommodations and residence conditions • Examining equipment requirements and safety rules for staying in the area • Study of additional safety requirements and rules when visiting specific	Files	• Links to normative documents • Files (notes taken) containing descriptions of good practices • Links to websites of licensed touristic agencies • Links to websites of mountain rescue service, Red Cross, etc. • Links to the websites of the observatories in Bulgaria • Guidelines for taking semi-structured interview

Subphase	Activity	Tools	Learning Resources
	research and observation sites (e.g. Observatory); • Study of good practices for the selection of learning activities • Inquiry (informal interview) with teachers on other subjects in the school (science, IT, sports, arts) about interest in inclusion in learning and ideas for interdisciplinary activities		
Phase 3: Data collection			**Duration** **Phase 3** – 6 learning hours
3.1. Collect documents' templates	Study on regulatory framework and collecting templates of required documents for working with students out of the school	Files	
3.2. Collect information about appropriate accommodations	Study offers by licensed touristic agencies suitable for students' training. Study of institutions and organizations providing equipment for observation of celestial bodies - observatories, planetariums;	Files: Electronic tables, text documents	
3.3. Collect information about equipment and safety rules for use of Virtual reality technologies	Study minimum requirements for mobile devices, provide virtual reality glasses, safety rules and safe behavior	Files: • Text document – a list of required equipment • Text document – specific safety rules	
3.4. Collect ideas for interdisciplinary students' activities in field	Study on good practices, presented on Phase 2	Files: List of activities	
3.5. Collect ideas by other subjects teachers	Study on the attitudes and interests of the teachers from the school, teaching other subjects	Files: • Text document – name of interested teachers and subjects they teach • Text document / audio record, video record with ideas for interdisciplinary activities	

Phase 4: Data analysis			**Duration** **Phase 4** – 4 learning hours
4.1. Categorizing data	Summarizing normative documents and templates, sorting documents which the teacher shell prepared for Regional management educational centres and school managers to be authorized to take students out of the school	File: list of categories and required documents and templates	
4.2. Ranking accommodation centres using different criteria	Evaluation and ranking the accommodation centres according number of students they can accept, conditions for training, price	File: electronic tables	
4.3. Summary of the information related to the equipment and safety	Extracting obligatory requirements for equipment and safety rules, when working with specific technology (for virtual reality, for augmented reality or for stargazing equipment such as telescopes). Selecting additional technical requirements.	Files: • List of needed equipment • List of safety rules • Define minimum technical requirements for the equipment (mobile phones, virtual reality devices)	
4.4. Summary of the appropriate activities	Summarizing literature review and good practices examination results, as well as other teachers ideas related to the students' learning activities	Files	
4.5. Summary of attitude of other school STEM teachers	Listing teachers who would participate in the training design and delivery	Files	
Phase 5: Interpretation of the results			**Duration** **Phase 5** – 8 learning hours
5.1. Forming of school team	Selecting a team of teachers who will organize and manage training	File: List of selected teachers and disciplines they teach	
5.2. Selecting an observatory/planetarium/ museum	Select appropriate facility-observatory, planetarium, museum, etc.	Search in the web, shared ideas from more experienced teacher	Internet links for the selected places
5.3. Selecting a touristic agency (if the selected observatory/ planetarium/ museum is outside the school location area)	Selecting appropriate touristic agencies. Contacting selected touristic agencies for precising details. Selecting accommodation and place for training	Files: • List with selected touristic agencies and their contacts • Contract template *Note*: This activity can be completed later before the training according to the Regional educational managements centres deadlines	
5.4. Documents preparation	Writing the required documents:	Files	

	• Description of the travelling • Instructions for students • Instructions for parents • Declarations • etc.		
5.5. Training design	Create a basic design for observatory training and classroom training with virtual reality technologies: goals, activities, responsibilities, materials, equipment	Files: • Text file – design description • Folders, containing electronic resources prepared in advance (for example star maps, location maps, tables to fill)	Template for training design description
5.6. Reflection	Discussion in teams on the possibilities for contextualizing the common scenario design for each representing school and teacher, showed interest to participate	Reflection	
Phase 6: Communication			**Duration Phase 6** – 6 learning hours
6.1. Scenario design presentation	Presenting the design of the training scenarios in front of the whole groups	Files: • Computer presentation (*PPT, *PPTX, *Prezi, others), • Text documents (*DOC, *DOCX, *PDF, others) Discussion, comments, feedback by other participants to the presenting team	Assessment card for evaluation of the training design
6.2. Feedback	Participants provide critical feedback, suggestions, comments to the presenters	Discussion	
6.3. Communication with stakeholders	Discussion on the methods for formal communication with different stakeholders – school managers, parents, students, colleagues	Discussion Notes Forum - online	
6.4. Possibilities for follow-up public dissemination of the results	The participants generate ideas for public presentation of the results after the training delivery – selecting a repository / online platform for sharing experience, collecting artefacts (photos, videos), selecting appropriate public events for dissemination – conferences, seminars, etc.	Mind map	
6.5. Reflection at the end of the teachers' training	The teachers assess the role of the IBL in comparison with other teaching / learning methods, assessing	Reflection	

	advantages and disadvantages of the IBL.		
6.6. Reflection after the teachers' training	The teachers share experiences, problems met and approaches used for solving them. They provide self-assessment of the design developed during the training and generate suggestions for improvement.	Reflection	Self-assessment cards

Source: ELITe Project ("ELITe," 2018).

A few of the subphases will be discussed in the following sections.

"Dream"

As it was defined in the section "Dream" and Reality Scenario - "dreams" are online tools, virtual reality, augmented reality and other. So this section describes two "dream" apps which we use in our teacher training scenario - SkyView® Free and StarTracker VR. Both apps are virtual reality apps. First of them do not need VR device but second of them does.

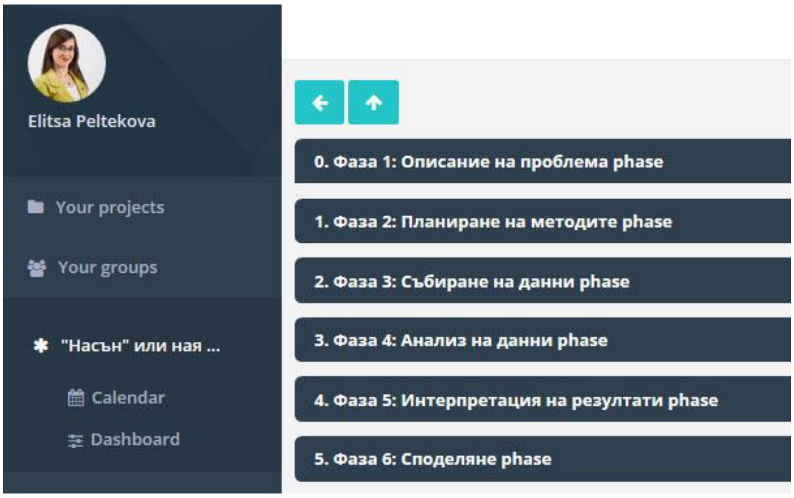
SkyView® Free app and StarTracker VR app are tools in subphase 1.1 Motivation from Phase 1 in Table 1. Apps serve Individual work in this phase:

- *During the observation, the whole group is divided on two. On the half group the eyes are tied with a scarf/bandage, and on the other half -not. Trainees work in pairs - one with tied eyes and the other –not. The person without a bandage needs to explain enough clearly what is visible on the sky (in the smartphone application, with the virtual reality glasses or with the telescope). Then the roles are exchanged.*

<u>Digital Scenario in Dojo IBL</u>

Digital scenario "Dream" and Reality (in Bulgarian language) is accessible on ELITe's web platform DojoIBL ("DojoIBL," 2017) (Figure 2). Here is the web address: http://dojo-ibl.appspot.com/#/inquiry/5442916239540224. Platform offers five different languages – Spanish, English, Dutch, Bulgarian and Greek.

Figure 3. *"Dream" and Reality Scenario in DojoIBL*



Souce: ELITe's online IBL platform ("DojoIBL," 2017).

Sky View® Free

In scenario SkyView Free app ("SkyView® Free," 2018) is used in Phase 1 to find popular constellations (zodiac constellations). This app allows users to observe popular constellations, locate planets in our solar system, discover distant galaxies, and witness satellite fly-bys. It does not need internet connection or VR devices as Google cardboard, the smartphone itself is enough (Figure 3). It is also an advantage this educational app is free of charge.

Figure 4. *Sky View Free – Virtual Observation of Sagittarius (Constellation)*

Sky View Free Logo

Star Tracker VR

It is a mobile planetarium in VR which is designed for astronomy enthusiasts to explore the universe - stars, constellations, planets. This smartphone application needs VR device (Figure 4) where smartphone's display is divided into two and smartphone should be inserted in the VR glasses. Objects in the center of user's eyes automatically are highlighted and pops up with information box. Great feature as in the previous app is that Star Tracker VR app ("Star Tracker VR," 2018) is also available offline. And it is for free.

Figure 5. *Star Tracker VR – Virtual Observation of Leo (Constellation)*

Star Tracker VR Logo

Reality

"Reality" is considered a real place for educational visit – science center, observatory, other.

In subphase 1.1 Motivation from Phase 1, in Activity is defined task: *Look for your zodiacal constellation on the sky map. Describe where it is located, at what time of the year it is visible to us. Can you show it in the sky? Organize a visit to an observatory where, with the help of a telescope, you can observe the stars in "reality". Set the GPS coordinates of the observatory and set a meeting time there.*

The Astronomical Observatory at the Sofia University "St. Kliment Ohridski" (Figure 5) is our choice for the "reality". This is the place where the trainees will visit and where observation with telescope is possible.

Figure 6. *The Astronomical Observatory at the Sofia University "St. Kliment Ohridski" and Some of its Telescopes*

Source: Photo of Astronomical Observatory (BNR, 2017), Photos of telescopes (Nachev, T., 2016).

Students and teachers leaving close to such observatories as in our case could have the real experience. But for the rest we offer a journey to real world though Virtual Reality.

Conclusions and Future Works

Building of a new educational reality in Bulgaria is an important task for taking up a significant place in the European and world educational space. The problem of adaptation, successful integration, the acquisition of good educational methods and means becomes a guarantee of success and development of key competencies. Creative thinking of the young person can be supported by the appropriate use of electronic tools and devices in the teaching and learning process.

We conducted survey (Peltekova, 2018) among 150 Bulgarian teachers. It investigated teachers’ VR awareness and teachers’ predictions about VR technology application in their work. The results of the survey are going to be analyzed and presented in future work directly related to this scenario. Important aspects of Responsible Research and Innovation (Health and Ethics) are being considered. Rethink and revision of the developed scenarios is needed.

References

BNR. (2017, April 28). Photo of the Astronomical Observatory at the University of Sofia "St. Kliment Ohridski. Retrieved July 21, 2018, from http://bnr.bg/post/100825128/astronomi-vi-ochakvat-utre-v-observatoriata-v-borisovata-gradina.

Danish Technological Institute. (2016, February 4). Does the EU need more STEM graduates? - EU Law and Publications. Retrieved July 21, 2018, from https://publications.europa.eu/en/publication-detail/-/publication/60500ed6-cbd5-11e5-a4b5-01aa75ed71a1/language-en.

DojoIBL - web platform for e-inquiries. (2017). Retrieved July 21, 2018, from http://dojo-ibl.appspot.com/#/inquiry/5442916239540224.

ELITe’s Bulgarian Scenarios. (2016, September 1). Retrieved July 21, 2018, from http://learning-in-teaching.eu/index.php/en/intellectual-outputs/io4/bulgarian-scenarios.

Enhancing Learning in Teaching via e-inquiries. (2018). Retrieved July 21, 2018, from http://learning-in-teaching.eu/index.php/en/.

Google Cardboard – Google VR. (n.d.). Retrieved July 21, 2018, from https://vr.google.com/cardboard/.

Miteva, D., Peltekova, E., & Stefanova, E. (2014). Research approaches in teaching and learning: weSPOT technology tools (pp. 2580-260). Presented at the International Conference in Education and new developments (END 2014).

Nachev, T. (2016). The Astronomical Observatory at the University of Sofia “St. Kliment Ohridski.” Retrieved July 21, 2018, from http://astro.phys.uni-sofia.bg/EN/instrumentation_EN.html.

Pantelidis, V. S. (2010). Reasons to Use Virtual Reality in Education and Training Courses and a Model to Determine When to Use Virtual Reality. *Themes in Science and Technology Education, 2*(1-2), 59-70.

Peltekova, E. (2018). VR Survey. Retrieved July 21, 2018, from https://docs.google.com/forms/d/1gYmxMvM6bBrOe-uF2_SM3mK39JRkmI5ol3WsD-qmncU/viewform?edit_requested=true.

Roman Berka, Jiri Bittner, & Pavel Slavik. (2011). VR and HCI Labs at the Czech Technical University in Prague. SBC Journal on 3D Interactive Systems, volume 2, number 2.

ŠKODA Mobile Apps. (2018). Retrieved July 21, 2018, from http://www.skoda-auto.com/world/mobile-apps

SkyView® Free. (2018). Retrieved July 21, 2018, from https://play.google.com/store/apps/details?id=com.t11.skyviewfree&hl=bg

StarTracker VR -Mobile Sky Map – Приложения в Google Play. (2018). Retrieved July 21, 2018, from https://play.google.com/store/apps/details?id=com.PYOPYO.Star rackerVR&hl=bg.

VR Classroom in Czech Technical University in Prague. (2018, July 13). Retrieved July 21, 2018, from https://www.youtube.com/watch?v=Jka-39zBLqw.

Windows Mixed Reality headsets. (2018). Retrieved July 21, 2018, from https://www.microsoft.com/en-us/store/collections/vrandmixedrealityheadsets.