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DIGITAL STORYTELLING IN EDUCATION USING WEBGIS

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Abstract

The aim of this paper is to investigate the influence of the implementation of WebGIS Story Maps in teaching and learning. As an interactive digital storytelling tool, available online, it has considerable potential to enhance teaching methods and may help students develop spatial and critical thinking as well as inquiry skills. An interdisciplinary/cross-curricular approach was implemented in the Physics course as a case study. The research was conducted in two schools on Lesvos island: the Experimental General Senior High School and the General Evening Senior High School. The research sample was 45 students, who produced digital stories, during the interventions. The tools of the research were a pre and post test questionnaire and students' digital stories. The findings showed that students enjoyed participating in digital narrative activities, while at the same time they increased their knowledge of Physics.

Keywords: WebGIS, Story maps, Interactive digital storytelling, Physics, Geography

1. INTRODUCTION

1.1 Explore Importance of Interactive digital storytelling

Hamilton and Weiss (2005: p.1) stated that: "Storytelling is the oldest form of education. People around the world have always told tales as a way of passing down their cultural beliefs, traditions, and history to future generations. Why? Stories are at the core of all that makes us human". The authors argue that narrative has been used as a tool for the transmission of our knowledge and values, cultural beliefs, traditions and history to the next generations.

In the 21st century digital narrative is a creative process in which traditional narrative is combined with multimedia and telecommunication tools (Ohler, 2008). Digital storytelling supports diversified school environments, helps teachers apply tailor-made teaching and leads to the development of multiple intelligences that respond to all different learning styles (Frazel, 2009). According to Frazel, digital storytelling can motivate students to learn core curriculum content, provides hands-on activities, helps educators meet the needs of diverse student groups, promotes group activities, can support individualised learning, offers to students' opportunities to implement new technologies in their learning process. Digital narrative enhances students' digital literacy, an important 21st century skill (Robin, 2008; Signes, 2008). When students share their digital stories: a) develop empathy, as digital narrative allows students to share their experiences, understand their choices and broaden their own perspectives; b) understand better themselves, as digital narrative leads to self-reflection; and c) promote digital communities (Garcia & Rossiter, 2010; Robin, 2016). Thus, digital stories are a popular pedagogical tool for teachers of all specialities who work with diverse student population (Garcia & Rossiter, 2010).

The interactive digital narrative deals with the creation of a new form of media art that allows real time interaction through developing narratives, a mixture of traditional, oral storytelling in different media types (such as image, text, video and music) with communication tools, thus being an important tool for learning, training, and entertaining (Sharaha & Dweik, 2016). The combination of entertainment and learning has been established with the term "edutainment" (education+ entertainment), which, according to the literature, makes learning relevant, leads to increased and distributed learning (each person learns differently in different time periods). A wide range of technological tools and systems such as world wide web (www), hypermedia, multimedia and e–interaction are undoubtably an added value in teaching activities. Hypermedia also support the codification of knowledge, such as the development of mental models (Ayersman & Reed, 1998), an example of which is the perception of a spatial pattern on a web map. Coding and memorizing can also be facilitated by the use of organizational methods (Dee-Lucas, 1996) or scaling systems (guided browsing) (Carver et al., 1992). Furthermore, many platforms that help organize and manage hardware with alternative browsers support both encoding and memory. Thus, it can be concluded that a web tool used to create digital narratives has an added value for teaching and learning.

1.2. Background and literature review

Many studies have found that digital storytelling affects students positively in various ways and supports their learning by encouraging them to organise and express their ideas and knowledge in an individual and meaningful way (Robin, 2008). In addition, More (2008) used digital stories to increase social skills for children with disabilities. Bull and Kajder (2004) included digital storytelling in the language arts classroom and Royer and Richards (2007) increased students' reading comprehension with digital storytelling.

On the one hand, digital storytelling helped not only promote students' learning interests in different subjects but also helped build learning communities (Banaszewski, 2002). Many successful cases have found that digital storytelling is a promising instructional strategy. Van Gils (2005) summarized the advantages of using digital storytelling in education into five categories: (a) providing more variation than traditional methods in current practice; (b) personalizing learning experience; (c) making the explanation or the practice of certain topics more attractive; (d) creating real life situation in an easy and affordable method; and (e) improving students' involvement in the learning process. These identified advantages further encourage more educators to utilize digital storytelling in their instructional practice.

On the other hand, the development of Geographic Information Systems has led to their integration in the education over the last 30 years. GIS tools for data management and spatial analysis can be used in a variety of school subjects at all educational levels (Kidman & Palmer, 2006; Madsen & Rump, 2012). GIS applications also help teachers adopt a constructive approach and improve students' spatial abilities. Studies have shown that GIS combined with well-designed material, good planning and guidance can benefit students (Aladag, 2010).

Baker (2015: p.105) stated that: "Web-based GIS or WebGIS is powerful mapping and analytical functionality expressed within a web browser. Today, WebGIS comes in many forms from consumer navigational maps to versatile location analytics tools that allow for user-directed analysis and content discovery. The inclusion of real-time data from sensor networks, social media, and the larger GIS community can extend WebGIS-based instruction to every learner. Because of the increased power and customization, webGIS can now better support learning standards-oriented content in the natural and social sciences". It is obvious that

WebGIS as an interactive mapping tool could play an important role in education by allowing students to collect, analyse and visualize their data (maps) (Baker, 2005; Alvarez Otero et al., 2018).

In international literature, the WebGIS is reported to be an effective teaching and learning tool (Bodzin & Anastasio, 2006; Henry & Semple, 2012; Milson, 2011; Schultz, Kerski, & Patterson, 2008). Adjustments to WebGIS - like Storymaps, which combine digitised, dynamic maps with other story elements (i.e. title, text, legend, popups and other visuals) and facilitate the creator to convey a message effectively (Esri Story Maps Team, 2012) - can be introduced in the educational process. There are teachers that show willingness to work with colleagues to create interdisciplinary story maps as teaching tools (Strachan & Mitchell, 2014).

Other research has shown that WebGIS is particularly effective when used in an inductive, constructive learning environment (Baker & White, 2003; Huang, 2011; Milson & Earle, 2008; King, 2008). Positive learning outcomes from the combination of constructivism and geostationary technology in general (GST) are identified at all ages. The studies have shown that there is development of skills - such as improving data analysis (Baker & White, 2003; Bodzin & Anastasio, 2006) and an increase of cultural awareness and empathy (Milson & Earle, 2008).

Considering its pedagogical value, WebGIS is a promising tool for supporting the students' development of spatial thinking in an effective way, by using various technological tools to solve problems (Manson et al., 2014). Moreover, several studies (Drennon, 2005; Liu et al., 2010; Rachel, 2005; Solem, 2001) support the pedagogical value of problem solving when combined with GIS (PBL-GIS). According to Aladag (2010), students' learning is enhanced because they should trust their own thinking process, choose and use the necessary information and ideas about the problem, find a solution to this problem and choose the correct solution, learn by experiencing it, and thus being actively engaged in the learning process, since they have created a product.

Web mapping tools can also reduce training time because they use custom data and map interfaces (Baker, 2005; Henry & Semple, 2012; Huang, 2011) in easier and accessible paths. Through interactive mapping and analysis techniques, students develop spatial abilities like spatial distribution, spatial interactions, spatial relationships, spatial comparisons and temporal relationships (Hwang, 2013).

The model of "Technological Pedagogical Content Knowledge" (TPCK) conceptual framework is supported by the use of GIS in science teaching (Baker, 2015), where the teaching context is identified (a) in the curriculum; (b) in the environment and with resources; and (c) by the school and the school community (Bodzin, Peffer, & Kulo, 2012). Should teachers not be able to apply effectively TPCK model, learning outcomes may not be accomplished.

Finally, for the new school "School of 21st century", which aspires to open up to society, we are interested not only in the information itself but also in how this information can be disseminated out of the narrow classrooms' boundaries (For Students by Students), a target that WebGIS tools can meet.

2. METHOD

2.1 Research Sample

The research was conducted in two schools, the Experimental General Senior High School and the Evening General Senior High School, in Mytilene, Lesvos island, Greece. The participants were 46 students (64.4% female and 35.6% male), attended the 10th and the 11th grades (Table 1). The students produced digital stories as interdisciplinary Story Maps, in Physics subject (a compulsory).

Table 1. The sample

Cases	School	Subject	Ages	Students	Groups	Teaching periods
1	Experimental General Senior High School of Mytilene	General Education Physics	16 - 17 years old	40	Groups of 2 students	5 hours*
2	Evening General Senior High School of Mytilene	General Education Physics	22 – 56 years old	6	Individual	5 hours* *1 teaching hour=45 min

Moreover, a quadriplegic student participated in the Evening School, who managed the head guided mouse (Head Tracking Mouse), and there were some students with learning disabilities, such as dyslexia and other learning difficulties. These participants were important for the research because they showed us that digital narrative can support diverse classes (with students with disabilities), contributing to enhancing social and psychological abilities, and can therefore be used to support students with disabilities in inclusive classrooms, thus limiting these students' tendency to drop out school. School dropout in students with disabilities is a complex challenge for schools. Such a consideration should provide a supportive framework for differentiated based interventions, especially at the secondary education level, that truly meet the needs of more students. Based on the Greek legislation for people with special educational needs - being effective since the year 2000, the state and the school have the obligation to implement specific programmes, methods and materials so to include and facilitate the education of this kind of students in general education (Eleftheriou, 2009).

The Learning Center for All (National Center on Universal Design for Learning) (CAST, 2018) has set principles for curriculum development, offering all people equal opportunities for learning. The main principles are three, and were taken into account during this case study. Thus, for each student teachers must: (a) differentiate the content, considering the student's needs and abilities; (b) provide different activities taking into account the student's starting point and learning profiles; and (c) motivate the student to actively participate in different ways, according to his/her interests.

2.2 Design of Intervention

According to literature review, digital stories have been mainly used in teaching and learning about environmental, historical, and social issues, not in Sciences or, more specifically in Physics (Kotluk & Kocakaya, 2016). Storytelling, as a teaching strategy, was implemented in a study aiming at students' understanding of the concepts of Electricity and Electromagnetism. The findings have shown that students worked as young researchers by expanding their knowledge of and interpreting scientific applications to everyday life (Kokkotas, Rizaki & Malamitsa, 2010).

Ernst Mach (1919: p.247), who is considered to be the founder of Physics Science, has sought the relationship between Physics Science and History of Natural Sciences and argued that: “We can determine the true value and significance of these principles and concepts only by the investigation of their historical origin. In this it appears unmistakable at times, that accidental circumstances have given to the course of their development a peculiar direction, which under other conditions might have been very different”.

In the last sixty years, there have been numerous references to the integration of the History of Science into the teaching of Science (Matthews, 1994; Monk & Osborne, 1997; Rasmussen, 2007; Rudge & Howe, 2009; Sherratt, 1982, 1983; Wider, 2006). According to the aforementioned, the integration of History of Science in Science teaching increases students’ motivation and interests and develops positive attitudes towards science. Furthermore, it provides authentic images of how science works, reveals both the interrelation and differentiation between science and technology, fosters the connection among scientific communities, strengthens reasoning skills, develops higher-level thinking skills and makes students understand better the content of basic science. It also promotes multidisciplinarity among science and other subjects and attempts to fill the gap among humanities and natural sciences (Kokkotas, Malamitsa, & Rizaki, 2011). It has therefore been proposed that digital story telling can support the teaching of Natural Science (AAAS, 1990, UNESCO, 2000).

The evolution of the History of Physics in space and time shows that Science has coexisted in different ideological, philosophical, religious and political trends in different geographic and social backgrounds. The introduction of the History of Science to the educational process helps students realise that spatial and cultural differences can be united, and different ideas can converge to one. The effectiveness of this inclusion is useful in mixed classrooms, where differences in knowledge levels, ages, country of origin and individual features, can be found among students – for example, in the Evening Schools in Greece and in adult education. In the case of these schools, teaching Science is useful for students to acquire problem solving and decision making skills and ensure a better quality of life upon their graduation. It is a great challenge for teachers to find ways to teach sciences effectively to multicultural adults or not in a comprehensive way (Pappas, 2017). As far as the different age groups of adult learners are concerned, those in the age group 25 to 34 years old perform better (National Science Board, 2014). Recent research has revealed that adult learners between 46 and 50 years old offered a high number of correct answers in Physics exams (Karaoglou & Kotsis, 2015).

The purpose of the intervention was for students to understand the evolution of the theory of Electromagnetism in time and space. More specifically, students had to produce stories linear to the content of Electromagnetism from different perspectives. Students also had to interpret the experiment of Oersted as a result of the electric current, and recommend "how", "where" and "why" of the evolution of Electromagnetism. Additionally, they had to recognise the patterns of the locations visualized on a Web map, regarding events taking place during the evolution of the History of Electromagnetism. Then, students could compare different interfaces, check spatial patterns and relations in maps, decode map legend, written texts and incorporate images related to the historical evolution of Electromagnetism. During this process, it was observed that students also develop abilities of how to search and select valid information from various sources in order to create a story-map related to the subject they work on. Consequently, they are actively involved in the learning process, while they are developing skills in how to handle Story Maps and WebGIS and present the project outcomes in plenary. The lesson plan was designed to engage students in Physics course and lead them to an effective learning. It focuses on cooperative learning, enhancement of positive attitudes towards the subjects involved (Physics, Geography, ICT) and recognition of the other aspects of sciences in everyday life, through the emotional involvement in storytelling.

The steps followed were those that have been suggested by many researchers and educators of the digital storytelling process (Lambert, 2007; Midge, 2010; Ohler, 2008; Robin, 2016) and discussed below. The stimulus technique was used to introducing students to the process, a simple technique that allows students to think creatively, encourage them to generate original, interesting and productive ideas and solve problems (key competences). The story of Marie Curie, which was created, using Story Maps software, was presented. This story was, according to Ausubel (1963), the role of the "advanced organizer", in order to activate the students' interest for what they will follow.

Prior to the intervention, a questionnaire was delivered to the participants, and after that, students started working on the introduction worksheet https://drive.google.com/file/d/1uEX1BLvlBsG-fKg7Ou5k9l1PuXNsl150/view?usp=sharing. Initially, the students were asked to work on the introduction worksheet collaboratively, and the role of each student was decided. Their mission was to construct multimedia presentation - narrate, decode and categorise information from the sources provided and to actively and experientially access the activities to build cognitive structures by exploring (the duration to accomplish the above activities was two teaching hours). The purpose of the third teaching period was to create the storyboard. There was a peculiarity in this: the location. Teachers helped students write the storyboard, organize the story sequences, and select the right elements to be embodied e.g. multimedia, pictures etc. which combined narrative-multimedia maps for each point of their story. At the same time, teachers explained copyright and digital rights issues for the materials used. The objective of the fourth teaching hour was the use of Story Maps for creating digital stories. The students added special effects, such as video, avatar etc. to make their stories more attractive, adjusting the length of each multimedia element to narration text. Teachers provided some feedback to incorporate further improvements before the final form of the Story Map. The fifth hour was devoted to collecting the final questionnaire, which explored student changes in their attitudes, knowledge and skills. The students saved and shared their Story Map and then presented the digital story to teachers and classmates.

2.3 Research Tools

During the research a pre- and post-test questionnaire were completed by the participants which contained closed and open-ended questions related to the investigation. The first part included questions about students' demographic data, like gender, nationality and age. The second part had questions about participants' prior knowledge and familiarity (level of experience) of Information and Communications Technology (ICT). For example, students were asked if they have a computer (PC) at home, or where they use it, and if they have easy access to internet and how many hours during the day they have used a PC and which programmes, such as GIS, they use at a satisfactory level. In addition, they were asked if they were interested in Physics course at school, what motivated them, if the method of subject teaching made it difficult for them, if they like groupwork, whether they related other subjects like Geography, History or Physics. For example, whether it could be combined with a tool of another course e.g. the narrative word of Literature course, a historical source from History course or a geography map could be implemented in Physics course. Additionally, students were asked if they could easily describe a phenomenon in Physics, while interesting was the question of which hero they would like to be, for example French officer Charles Augustin de Coulomb, English physicist and philosopher William Gilbert, Danish physicist and chemist Hans Christian Oersted. Finally, there were some questions that tested their knowledge of Electromagnetism.

The final questionnaire included an evaluation of the Story Maps software that the students who used it should respond to. At first, when they were linked with website (https://storymaps.arcgis.com/en/), if they had the impression that it would be easy, if the software they were working with seemed interesting, if they considered it easy to handle and they could handle it independently of a teacher's presence. They were asked whether they encountered technical problems/weaknesses related to the quality of the software, positive-negative elements they found in the Story Maps software and whether they have to suggest some improvements. The second part of the questionnaire included an assessment of the students' activity. So, the students were asked whether they felt the activity was more difficult than they expected, whether it was complicated and caused them anxiety or whether they found it interesting. We checked whether the production of the story gave them a sense of satisfaction and whether the quality of the software (graphics, screen design) helped them keep their attention undisturbed. Moreover, if the story maps were close to their interests and preferences, the structure of the story maps helped them organize their material well and gain conviction that they would do the story. We were interested in learning whether students were actively involved in the activity, whether they were encouraged to read/work using sources that were not included in the material they were given, whether they worked well with the other group members, whether they enjoyed the process, whether they felt that the content of this activity was useful in terms of learning, and whether they understood better some concepts better than before.

The way of presentation they chose for their story was recorded, and, more specifically, whether they used geographic maps and found useful to add a map. Finally, they were asked whether they think the story maps software can be used in other teaching subjects or in their daily lives. The third part of the post-test consisted of questions from the pre-test related to the Physics course.

For the analysis of the questionnaires, the Statistic Package for Social Science (SPSS v21.00) was used. Descriptive and inferential statistics were used for data analysis. At the same time, a qualitative analysis of the stories-maps was made to collect additional data according to the research questions.

This phase had three different aims to: (a) access the level of students' technological competence with WebGIS and the usage of maps; (b) access the level of students' engagement; and (c) document the educational outcomes achieved through this process. The post-test (quantitative) was used to collect information about collaboration, knowledge acquired, spatial thinking and evaluation software-activity-of the course of physics by the students. Using more than one methods in this study (triangulation) for data collection, researchers could check their results. This is a way of assuring the validity of research findings through cross verification of information collected from two or more sources (Cohen, Manion, & Morrison, 2012).

Evaluation rubrics (DISTCO, 2015) and Jason Ohler's list of possible digital story evaluation traits (Boase, 2013) were used as a guide to choose some criteria, as an assessment instrument, to transform qualitative data to quantitative. The qualitative evaluation included six criteria according to Ohler, who suggests that from the list, the teacher or facilitator should choose up to six 'traits' (of which the students are made aware) which will be used to assess the story and story-making process. These criteria were: Purpose (aim(s) and objective(s)), Plot (the set of events that make up the story), Pacing of Narrative (the rate at which the events proceed), Story Content (the elements used to create the story), Technological Competences (complexity of technology) and Economy of Content (optimization of contents and quality); see Table 2. That is why we grouped the following features of the stories: The narrative technique, the number of points-stations in history, the theme of the images used (portrait, experimental layout, etc.), the type of picture (painting, stamp, etc.), the characteristics of maps (e.g. scale, point symbolism, background), the use of maps (use of map by point station or use of a map for the whole story, multimedia (video, avatar).

Table 2. The criteria for digital story maps evaluation*

Criteria	Definition of the criteria	Average 1	Good 2	V. Good 3	Excellent 4
Purpose	Aim(s) and Objective(s)	*It is difficult to figure out the purpose of the story.*	*There are a few lapses in focus, but the purpose is fairly clear.*	*Establishes a purpose early on and maintains focus for most of the story.*	*Establishes a purpose early on and maintains a clear focus throughout.*
Plot	The set of events that make up the story	*The events of the story are fairly well chosen, but not contribute to the overall meaning of the story.*	*The events of the story are good chosen and try to contribute to the overall meaning of the story.*	*The events of the story are well chosen and contribute to the overall meaning of the story.*	*The events of the story are creatively chosen, and contributed to the overall meaning of the story.*
Pacing of Narrative	The rate at which the events proceed	*No attempt to match the pace of the storytelling to the story line or the audience.*	*Tries to make an accurate order for the events, but it is often noticeable that the pacing does not fit the story line.*	*The order of the events matches story line and relatively engaging for the audience.*	*The order of the events matches the story line and helps the audience really "get into" the story.*
Story Content	The elements used to create the story (Ex. photos, video, sound)	*Little effort to use contents to create an appropriate atmosphere and/or to mix*	*An effort was made to use contents to create the story and/or to mix different multimedia*	*Contents create an atmosphere that matches some parts of the story. and different*	*Content is clearly relevant to the story, very well chosen for content (photos, music, video...etc.).and*

		different multimedia content (ex. photo with video).	*content (ex. photo with video), but it needed more work.*	*multimedia contents are mixed (e.g. photo with video)*	*matches different parts of the story.*
Technological Competence	The use of the technological tools	*Little transitions, effects, audio, and edits are used and/or appropriate to the subject matter.*	*Some transitions, effects, audio, and edits are used and/or appropriate to the subject matter,*	*Most transitions, effects, audio, and edits are used and/or appropriate to the subject matter.*	*Transitions, effects, audio, and edits are utilised and appropriate to the subject matter,*
Economy of content	Optimization of contents and quality	*Little optimization (e.g. too much contents, too little quality)*	*Good optimization (e.g. contents is somewhat balanced with obtained quality)*	*Very good optimization with some shortcomings (e.g. contents balanced with quality)*	*Perfect optimization (e.g. required contents, best available quality)*
Final score					

(*Adapted from: University of Houston, (2011). The educational uses of digital storytelling, http://digitalstorytelling.coe.uh.edu/pdfs/samplerubric.pdf)

2.4. Analysis

Descriptive and inferential statistics were used for data analysis. More specifically, descriptive statistics (frequency and percentage tables, bars, charts) were used to display data and grouped students' answers before and after participating in the digital narrative and creation of story map. Inferential statistics were used to compare the sample's answers (two data sets) before and after participating in this process. For this reason was used the dependent samples t – test.

Forty-five surveys were collected from the participants. Profile data from section one of the survey (age, gender, nationality) were recorded as written by the participants. The ages ranged from 16 to 56 years old, with an average of 19.58 years (SD=9,536), 64.4% of the respondents are girls, while 35.6% are boys and all the participants were Greeks.

Participants' responses grouped into categories "low", "medium", or "high", which recorded as a score of 1, 2, or 3, respectively, and compared to their self-reported level of knowledge, familiarity and use of ICT, level of ICT availability at their home, school or elsewhere, and level of experience with geospatial technologies.

In sections two and three of the survey, responses to the items concern students' knowledge of basic concepts, laws, and scientists of Physics and, more specifically, those of Electromagnetism. Moreover, there are some other items about students' attitudes towards the subject of Physics in a 5-scale Likert. All responses to the open-ended questions were coded, evaluated and grouped into identified themes corresponding to each question and analysed with SPSSv21.00.

The participants used their own personal way to document the evolution of Electromagnetism history. They used different elements, different maps, several multimedia and they chose the best Story Map application template, the best layout option for their exciting story (see below screen capture of Story Maps created by the students: Figures 1-9).

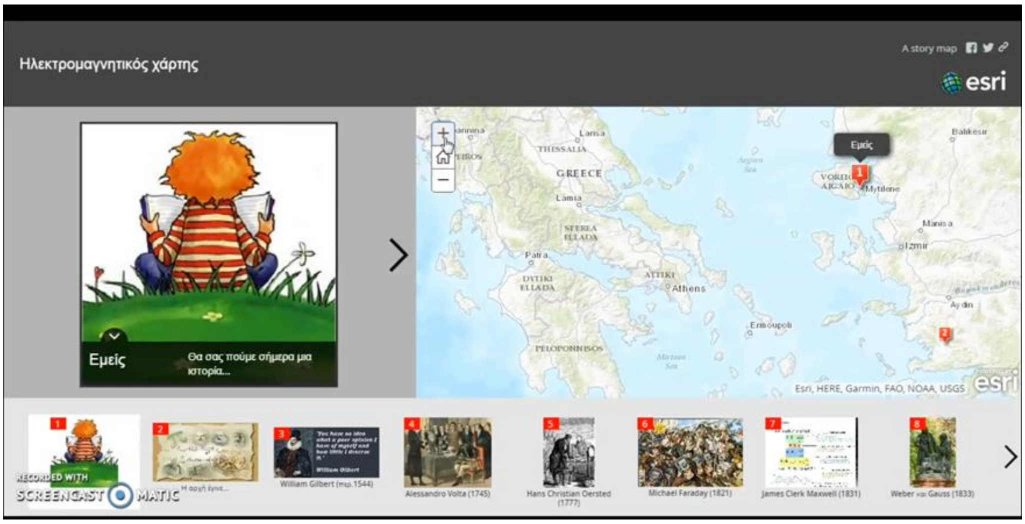

Figure 1. The students chose the first point of the Story Map to be their own place, which shows that students perceive themselves as part of the story

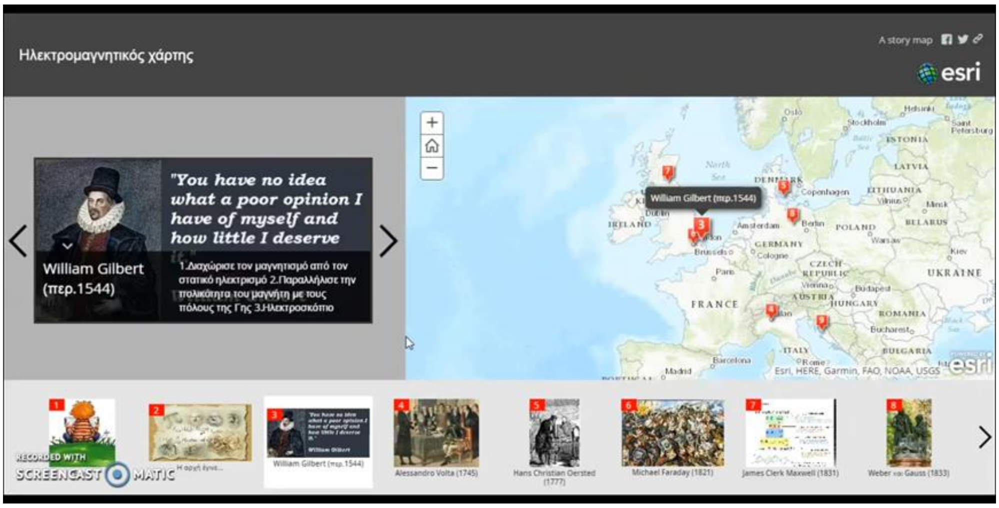

Figure 2. They chose the Story Map Tour as their application template

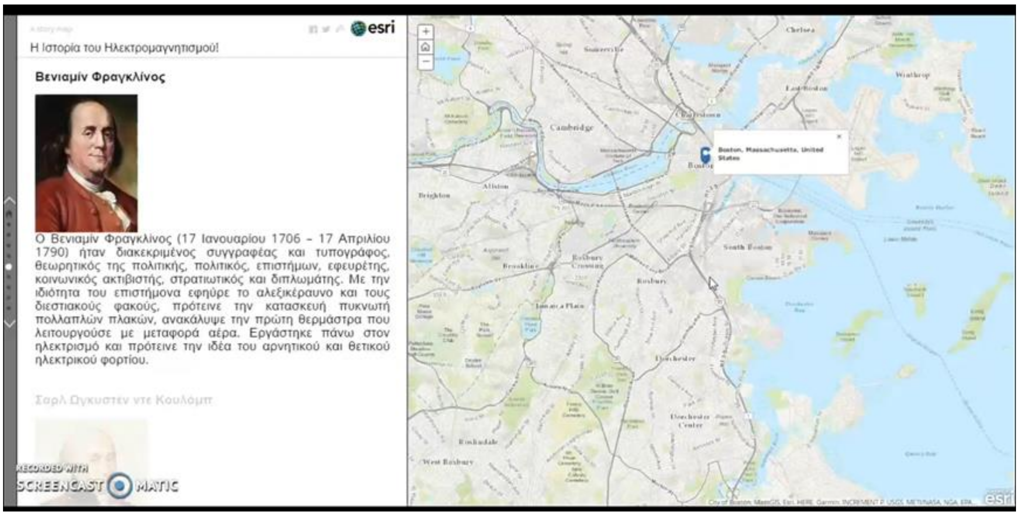

Figure 3. They chose the Story Map Journal as their application template and a different basemap

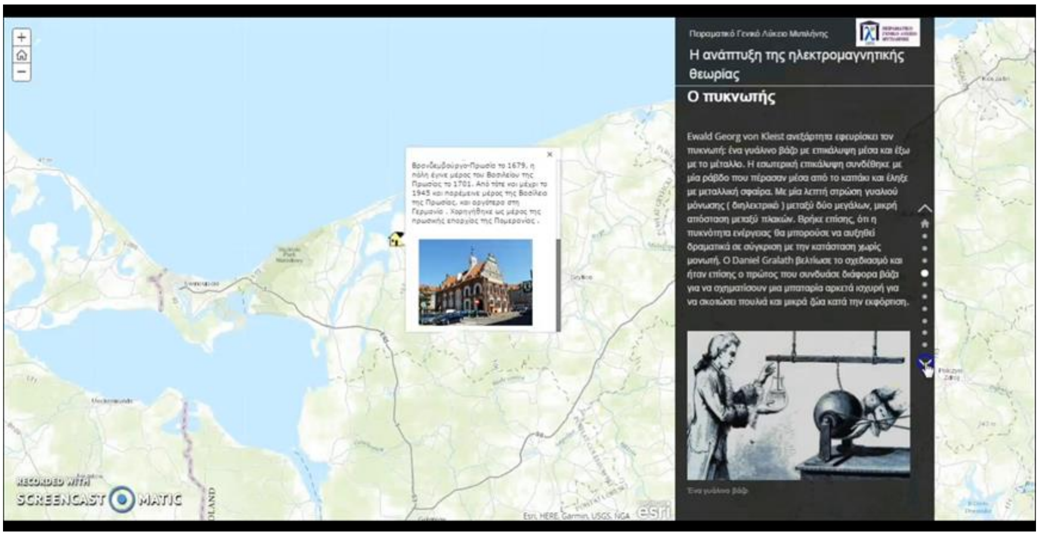

Figure 4. A house was their map symbol. This shows that they wanted to get involved in the process to a great extent

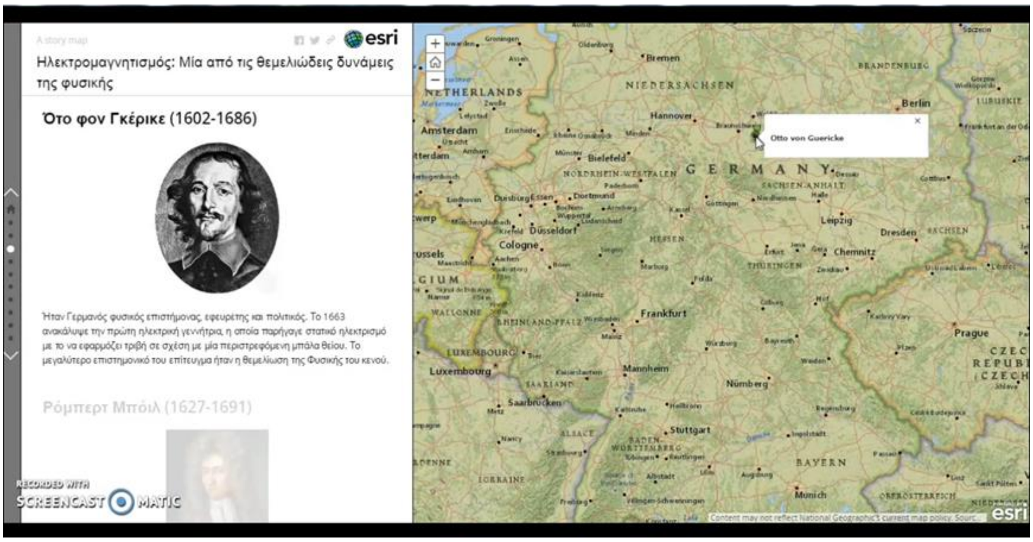

Figure 5. Different basemap, different layout, a different story

Figure 6. A stamp was used as a portrait

Figure 7. Boxing as a narrative technique: incorporating an intermediate narrative, the story of Alice, into the normal flow of history

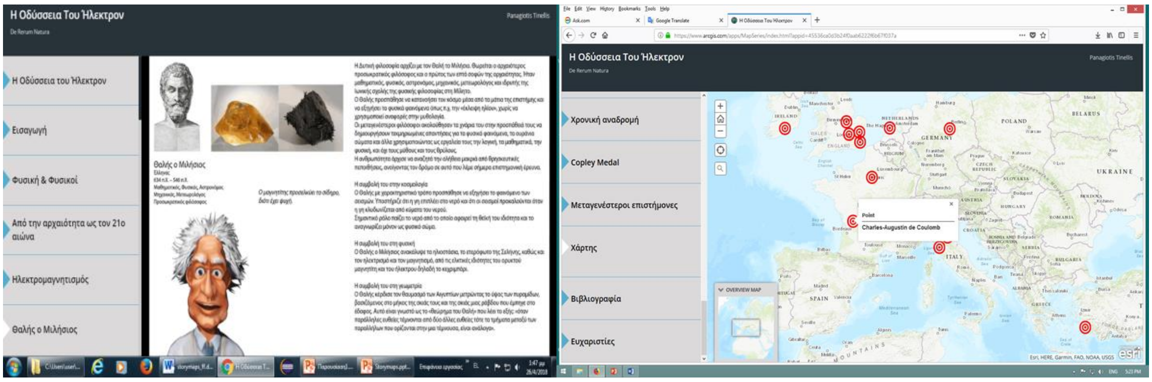

Figure 8. An avatar was used as a narrative technique

Figure 9. Identifying a spatial pattern

The content analysis of students' Story maps was based on the criteria for digital story maps evaluation (Table 2).

3. RESULTS - DISCUSSION

3.1 Major Findings of quantitative analysis

3.1.1 Knowledge and skills of PC use

The great majority of the sample (97.8%) has a PC at their home, but usually most of them use it either at school or at their friends' home (Fig. 10).

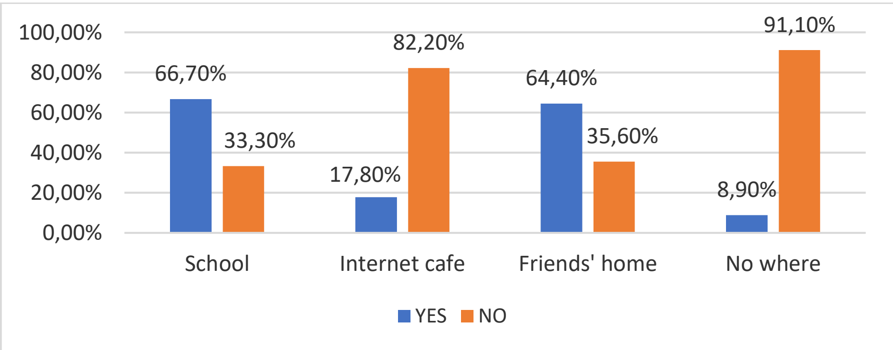

Figure 10. Place where students use PC

As far as the frequency of computer use per day is concerned, 37.8% of respondents use it for 1-2 hours (Fig. 11).

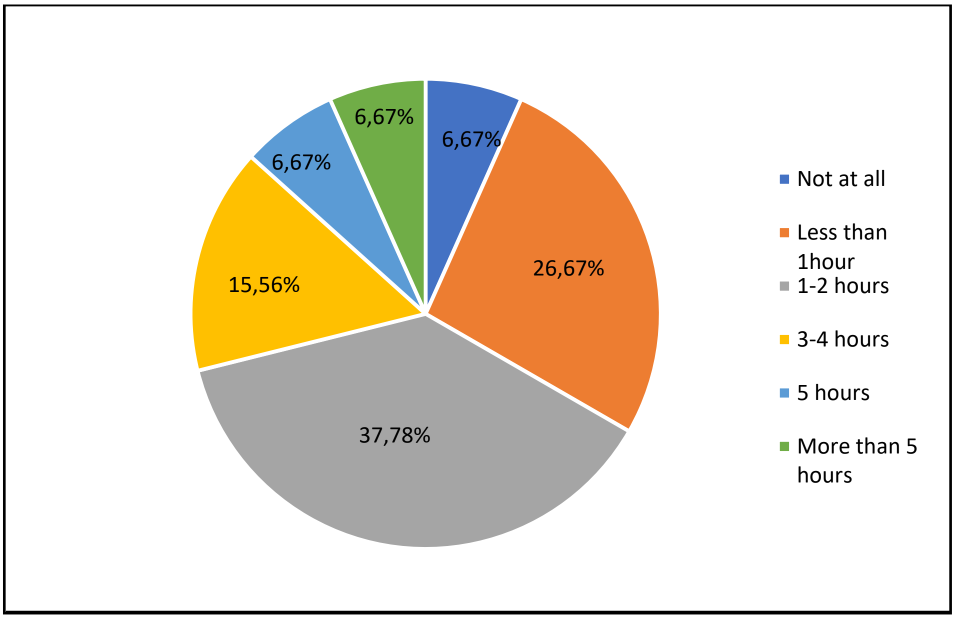

Figure 11. Hours/day students use PC

Furthermore, the great majority (97.8%) of respondents are aware of the Internet use, 95.6% of them have a good level of knowledge of Microsoft Office tools, they know social media applications (91.1%) very well, 73.3% play online games, 66.7% use learning platforms and 62.2% participate in chats. Finally, the great majority of respondents stated that they have no knowledge of geotechnologies or GIS (91.1%).

5.1.2. Software evaluation

Results revealed that students considered the use of the Story map software more difficult than they expected (52.17%), possibly due to some technical problems they faced during the creation of the stories. However, most of them described it as easy to handle, which may explain that most could handle it independently of their teacher's presence (73.33%).

The work was interesting, although it was a little harder than what they thought it could be (69.57%). However, the work was not complicated and, therefore, did not stress out students; instead, it gave them a sense of satisfaction.

The software seemed to be nice in presentation and of high quality (e.g. graphics), which helped them keep their attention. Also, students described it as a useful tool that helped them organize their stories, especially by incorporating maps.

The students actively participated and worked productively with their group members. Furthermore, they were motivated to read/work using additional sources not included in the material initially provided.

3.1.2 Activity evaluation

Students assessed the content of this activity as very useful for them in terms of learning (69.56%) because of its contribution to a better understanding of the subject's concepts. Moreover, they enjoyed the process very much (68.88%).

One further conclusion concerns the differences in students' attitudes before and after the intervention included the use of digital storytelling software. Prior to the activity, students believed that physics teaching can be matched with mathematics (88,9%), with the introduction to computer science principles (57,8%) and the chemistry subject (53,3%). After participating in the activity, students believed that physics teaching can be matched with Mathematics (76,1%), Chemistry (60,9%) and Geography (60,9%) as well as History (58,7%) and Philosophy of Science (52,2%). This change may happen because they chose to use maps and other sources in their narratives. Moreover, before the activity, the students reported that only to a moderate degree (42,2%)tools of other subjects (for example: narration from Literature course, an historical source from History subject, or a Geography map) can be combined with Physics. Instead, after the activity, the students reported that to a great degree (51,3%) indicating how much such a tool could be combined with the Physics subject. This difference, however, was not found to be statistically significant.

3.1.3 Physics subject

The results revealed that after the activity more students stated that that they could easily describe a phenomenon of Physics or explain a number of phenomena compared to the number those before the intervention. This difference was found to be statistically significant, meaning digital narrative improved their ability to describe a physics phenomenon ($p<.001$).

To a great extent, students believed that the content of the Physics subject might be important for their everyday lives both before and after the activity, without any statistically significant difference. Another interesting finding was that the number of keywords the participants offered for the description of the “History of Electromagnetism” after the intervention increased compared to those offered before it, although not at a statistically significant level.

Additionally, while before the activity students considered that the French officer Charles-Augustin de Coulomb was the one who introduced the adjective "electrical" to describe how objects can be electrified by friction, after the activity they offered the correct answer that the first who introduced “electrical” was English physicist and philosopher William Gilbert. Similarly, while before the activity the French officer Charles- Augustin de Coulomb was the person they admired, after the activity was Danish physicist and chemist Hans Christian Oersted. Both differences were found to be statistically significant ($p< .001$)

Further differentiation was observed in the responses given before and after the activity in which natural forces can interact. Prior to activity, most students responded that this happens only between two stationary charged objects, which is a wrong answer. After participating in the activity, they replied that this happens in several cases like between charged objects (either in contact or not), between two magnets or between a magnet and a charged object and, of course, between an electrical wire and a magnet. This difference was found to be statistically significant ($p< .01$). Finally, there were no statistically significant differences in the students' responses regardless the school type (that is, whether the students were from General Senior High School or the General Evening Senior High School).

3.2 Major Findings of qualitative analysis

Qualitative analysis also led to important conclusions. First, it was found that in all cases a report/narration was used with comments, but a few used the element of boxing. Paintings and more specifically portraits dominated. Second, large-scale maps were used, and in particular map by-site mapping was used. In the majority of cases, the background of map was Topographic (WGS84). Moreover, pinch was the most preferred symbol to identify the locations on students' maps. Third, descriptive data for the locations were added in the students' story maps. Finally, gender and age were not found to play an important role in choosing narrative ways.

Overall, students enjoyed participating in the digital narrative activity as they found it interesting, sometimes exciting, something that was evident from their narratives and the variety of media they used (e.g. avatar, story of Alice, etc). Technical problems faced during the Story maps creation did not affect the students' positive attitudes towards the software they used, as it allowed them to create nice stories, especially when using maps.

The digital narrative seemed to lead to some variations in the respondents' opinions on the connection of Physics subject with other subjects and in terms of their knowledge enhancement in the Physics subject. Working in groups was found to be both interesting and effective for students, an important finding for the Physics subject. Consequently, since digital narrative facilitates and enhances students' interactions and increases their knowledge level, as mentioned before, teachers should integrate it in their classroom practice for an effective learning.

4. CONCLUSIONS

Web GIS is a GIS system that uses web technologies that is mainly composed of data handling tools for storage, recovery, management and analysis of spatial data. Students' ability to apply deductive reasoning that leads to conclusions and to act upon promotes development of content knowledge as well as analytical skills and critical thinking. Furthermore, the use of the tools helps students develop digital literacy and empowers them to complete complex tasks and to design projects. Moreover, the use of Story maps enables students to develop spatial thinking, while they don't know that they learn geography.

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