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The Case of Literacy Motivation:
Playful 3D Immersive Learning Environments and Problem-Focused Education for Blended Digital Storytelling

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ABSTRACT

The University of Patras' Library Services designed and offered to primary and secondary schools the pilot educational program "From the Ancient to the Modern Tablets", featuring immersive multimedia learning experiences about the book history. The pilot program consisted of three stages: a playful library tour, followed by an interactive game-based digital storytelling activity with game elements, and a collaborative creative reflective hands-on activity. Utilizing the avatar psychology power, the visualization and simulation affordances of 3D immersive learning environments and the appeal of storytelling and game-based learning, the "gamified" blended narrative on the book evolution enabled learning as problem-focused, embedded and context-generated. An additional research study was conducted to investigate teachers opinions regarding the effectiveness of the 3D Virtual Immersive Environment(s); this focused on students' learning and thinking skills in the socio-cognitive, psychomotor and affective domain. This work exposes the pedagogical design, presents the socio-technical development and reflects on the initial research findings.

KEYWORDS

3D Virtual Immersive Learning Environments (3D VLE), Digital Storytelling, Gamification, Library, Multi-User Virtual Environments (MUVEs), Problem-Focused Education (PFE), Second Life

1. INTRODUCTION

At times libraries have been criticized for becoming increasingly outdated or irrelevant in the age of ubiquitous access to knowledge and information. We argue that in the era of lifelong learning, libraries can become places and spaces, which host learning opportunities that are accessible to all. Beyond fulfilling their traditional role of offering information and knowledge, libraries can be transformed and evolve to critical and reflective knowledge providers, can offer creative workshops and develop innovative, open learning spaces for any age. Universal access can be achieved with the help of educational technology specialists and learning innovators design thinking.

As an integral part of its mission the Library and Information Center (LIC) of the University of Patras considers that to stay accessible to and collaborate with schools so as to support school teachers and students in their learning ventures. This approach is aligned with the function of Libraries in the 21st century as "third places" (Montgomery & Miller, 2011) that facilitate learning in multiple ways. "A third place is an open accessible area or space where citizens can congregate voluntarily

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and interact to produce social value." (Oldenburg, 1999). The two other places where people spent their time daily are workplace and home.

In 2012, the University of Patras decided to launch a new institution-wide initiative called "Schools go to the University", (University of Patras, 2014), and invited all interested departments to design and offer short educational programmes suitable for primary and secondary education schools. All programmes were communicated to schools of the Prefecture of Achaia. Interested schools could arrange visits for one or several class to any programs during a specified spring open-door two-week period.

Responding to this invitation, LIC designed the pilot educational project "From the Ancient to the Modern Tablets", (University of Patras Library Services, 2014), an immersive playful multimedia learning experience about the history and future of books. The programme combines digital storytelling, 3d virtual immersive learning environments, and gamification, utilising the concepts of problem-focused education.

The current work is an extended version of the work presented in a conference publication forum, co-authored by Mystakidis, Lambropoulos, Fardoun, and Alghazzawi (2014). The extended work elaborates more on the pedagogical design, the socio-technical development principles and the formative assessment results of the educational programme.

2. THEORETICAL BACKGROUND

In this section, there is an exposure of our main theoretical terms and pedagogical design concepts. Thus sections 2.1-2.4 outline the conceptual essence and personal motivation to aim at constructing this type of pedagogical instrument that mainly targets at historical events' finding and understanding. The whole research study has been carried out in an experimental, rather unusual, but yet innovative and effective way, which revealed interesting conceptual pedagogical aspects of problem-focused education and enquiry-based learning.

2.1. Digital Storytelling

Storytelling is a universal and diachronic medium for knowledge and wisdom transfer across cultures (Bruner, 1991). Storytelling is the socio-cultural activity of sharing stories, often with improvisation, theatrics, or changing the emphasis on different aspects. Historically, various stories and plots have been shared by humans as a means of entertainment, education, cultural preservation and instilling values and cultural norms. Crucial elements of storytelling are the plot, the characters and the narrative points of view. The term 'storytelling', however, has rather been used in a narrow sense to refer specifically to oral storytelling and also in a looser sense to consider techniques used in other media to unfold or disclose the narrative of a story (Wikipedia, 2017). Further digital storytelling uses contemporary technologies, such as digital media to utilize the ancient form of communication through stories. Moreover, digital storytelling utilizes visual and auditory elements to compose and deliver valuable meanings and messages. Music and sound effects can accompany the narrative to add atmospheric tension to the experience. This type of storytelling is a rather compelling method to construct and organize learning both for children and adults (Ohler, 2006). It can be used both as a teaching and learning strategy, for example as a vital component in an organized student (individual or group) project. Van Eck argues that narration and storytelling are two of the most powerful instructional strategies (Van Eck, 2007). "Stories allow us to learn from the experience(s) of others without having to face another person's personal consequences…" (Baer, 2013). McAdams has argued that the human behavior is being guided by narrative construction (McAdams, 2006). Storytelling has also been found to be an effective method to increase information retention. Adval and Wyer (1998) have demonstrated that adults tend to remember facts and other pieces of knowledge more accurately if they encounter them in a story rather than reading them in a list or simple text format (Adaval & Wyer, Robert S., 1998).

Digital storytelling has been used world-wide in classroom education with excellent pedagogical results (Clarke & Adam, 2012; McDrury & Alterio, 2003; Moon, 1999). More specifically, digital storytelling has been found to improve 1) student comprehension, 2) logical thinking, 3) literacy, written and oral language skills, 4) student memory, 5) cross-curriculum learning (Haven, 2007). In most instances, however, digital storytelling has been used as a student activity for the design and production of digital artifacts, usually as a part of an assigned project or as the means of individual or group reflection. In the context of our study, we chose digital storytelling as an enquiry-based and problem-focused education framework to construct an overarching narrative for the achievement of selected, pre-defined teaching aims and learning objectives.

2.2. Increasing Commitment through Game, Gamification and Play

A recent (revisited) addition to the educators' arsenal is the target of increasing interest in playful activities and commitment to learning through games, that is gamification and playful design. During well-designed immersive games children and adult learners could experience the state of a problem, enquiry, or simple fact flow as an immersive learning experience. Otherwise stated the latter state of flow can be evidenced as the optimal state where between boredom and anxiety a potential learner can utilize an ever-changing learning identity through achievement of balance between learning challenges and skills to be acquired (Csikszentmihalyi, 1990). Such games can be used as appropriate learning experiences according to Vygotsky's zone of proximal development (Lambropoulos et al., 2012). A plethora of games have frequently been used to initiate, enhance and facilitate learning (Gee, 2004; Squire, 2005). Story and digital storytelling is a game mechanic in games to provide a compelling narrative. One common form of digital storytelling applied in games is, for instance, "the hero's journey" (Goldstein, 2005), which focuses on adventures and values. Gamification is the incorporation of game mechanics and elements in a non-gaming context (Deterding, Dixon, Khaled, & Nacke, 2011). Schiller already in 1875 pointed out that play is the expenditure of exuberant energy. Gamification, games and play as such are distinct strategies to incorporate the element of fun in the learning process, so students' commitment would increase.

2.3. Problem-Focused Education (PFE) and Manifold Thinking Skills

Problems are challenges in real-life situations that have been used as primary building blocks to design socio-cultural, situated student-focused learning experiences for attendance-based and distance learning programs (Margetson, 2001). Problem-based learning (PBL) orchestrates student learning as a process of apprenticeship on solving real-life problems (Margetson, 2001). The aim of problem-based learning is to provide a bridge between learning and real life and encourage manifold thinking. Manifold thinking includes four types of thinking skills: creative, critical, caring and reflective thinking (Valtanen, Berki, Kampylis, & Theodorakopoulou, 2008).

Proponents of problem-focused education (a variation of PBL) argue that learning, should be structured around meaningful, complex real-life problems instead of isolated subjects and self-contained courses. Problem-focused education (PFE) follows a more flexible than PBL approach: PFE 1) begins with a problem, 2) presents the problem as a real-life situation, 3) supports students' manifold thinking and working in a group, 4) encourages students to identify their own learning needs and take responsibility of their own learning processes, and 5) encourages assessment and evaluation of the learning process and its learning outcomes (Valtanen, Berki, Georgiadou, Ross, & Staples, 2011).

In this context, we adopted the principles of problem-focused education and combined them with digital storytelling in 3D virtual immersive learning environments. In so doing, we designed learning activities to 1) facilitate students' independent/individual or/and group learning, 2) increase the responsibility of own learning processes; 3) develop manifold thinking and other skills and, finally, 4) advance deep learning strategies in the educational designs of the future.

2.4. 3D Virtual Immersive Learning Environments

3D Virtual Immersive Learning Environments (3D VIEs), also called 3d Virtual Worlds or multi-user virtual environments - MUVEs are three-dimensional computer-generated virtual spaces that enable educators to enhance both attendance-based teaching (Nussli & Oh, 2014) and distance learning (Endicott-Popovsky, Hinrichs, & Frincke, 2013; Hill, 2011) by applying socio-constructivist instructional methods such as situated and experiential learning (Dede & Dawley, 2014; Liz Falconer, 2013). More specifically, 3D VIEs are flexible learning tools for utilizing approaches of storytelling to create simulated (L. Falconer & Frutos-Perez, 2009) and game-based learning experiences (Hill & Mystakidis, 2012).

The Library and Information Center (LIC) of the University of Patras offered the first open course series in 3D VIEs in Greek higher education in the frame of a project called "Open Workshop on Information Literacy". As a result, the creators of the programme received a national seal of good digital teaching practice (Mystakidis & Tsakonas, 2012).

In this instance, we used 3D VIEs as a digital medium to narrate a transmedia story, by visiting various virtual environments and directing immerse learners into different historical times and ancient civilizations. Transmedia storytelling expands the content delivery of a story across multiple platforms and media such as television, internet, social media, mobile applications etc. (Jenkins, 2006)

3. RESEARCH QUESTION AND RESEARCH METHODOLOGY

3D virtual immersive learning environments and digital storytelling have not been introduced into Greek primary and secondary education as teaching tools and learning methodologies. Notwithstanding the underlying technologies are expected to be familiar to some students, primarily through computer games in 3D environments. Thus, our initial intention was to provide teachers and students with the opportunity to experience different teaching and learning approaches.

Secondly, we wanted to find out about the local school teachers' perceptions on the short-term impact of the learning experiences of their students. Our research aim was to capture the initial teacher evaluation of the pedagogical potential and effectiveness of the employed instructional method for literacy motivation in their class students. The teachers had the opportunity to observe their students' behaviour during all stages of the programme. Teachers were especially encouraged to observe and interact with the students during the final part of the programme, which was considered to be the stage of the creative collaboration and reflection.

More specifically we aimed at tackling and answering the following research question:

Could enriched with (digital) storytelling and problem-focused education concepts 3D Virtual Immersive Environments have a positive impact in facilitating primary education students' learning?

To address the above, we used a mixed research methodology approach, which is also found at the work of (Venkatesh, Brown, & Bala, 2013). The approach comprised the following components:

A. a teacher survey (quantitative research) in combination with
B. unstructured interviews (qualitative research).

First, the teachers were informed about the research study through the Library's pilot project and were invited to voluntarily evaluate the students' reactions by completing an anonymous online questionnaire that is our main research instrument. The questionnaire was designed according to Cohen et al's (Cohen, Manion, & Morrison, 2007) principles of questionnaire designing. The final questionnaire consisted of twenty-nine questions organized in three sections, focusing on the:

- Overall formative assessment of the experience;
- Assessment of the impact of used technologies on students' in the cognitive, affective and psychomotor domain;
- Teacher demographics.

Second, after the completion of the educational pilot programme, we conducted short unstructured oral interviews with volunteering teachers. During these interviews, we invited teachers to comment on the programme's design (e.g. educational aims/aspects), implementation (e.g. appearance, interface issues), as well as their students' reactions, interactions and performance, as well as raise issues and make further suggestions for improvement. Their answers were recorded by writing notes.

Finally, during the realization of the pilot project, we were able to collect further data and combine data with anecdotal encounters, reactions and spontaneous comments and questions from the students, by observing students behaviour and learning attitudes.

4. PEDAGOGICAL DESIGN AND RESULTS APPRAISAL

After a series of unstructured interviews and consultations with primary school teachers, the following learning objectives were identified for the "From the Ancient to the Modern Tablets" programme:

- To motivate extracurricular reading and promote earlier, historical events and knowledge literacy;
- To develop socio-cognitive links among books reading, writing, and knowledge acquisition through information and communication technologies;
- To acquire an introductory set of user skills through a tablet; and
- To practice team collaboration and collective knowledge sharing.

An important challenge was to avoid and overcome the passivity and compliance (and sometimes conformity and boredom!) that students face when they are merely presented with events and facts. So, we regarded active user engagement as a critical success factor. Thus, to maximize the students' excitement and engagement while targeting at a project with high problem-focused education quality and learning value, we decided to construct the educational programme around selected game mechanics. The learning experience consisted of three components and stages:

A. A playful library tour (Figure 1),
B. An interactive game-based digital storytelling activity with playful elements, followed by
C. A collaborative creative hands-on group reflection activity.

At the first stage and upon arriving at the Library, students participated in a 30-minute playful tour. The latter features various problem-focused education concepts and game mechanics incorporated and built-in this introductory learning component; such concepts and features are: team play, competition, challenge, information seeking, quests, choices, surprise, curiosity, and expression.

At the second stage, in the Library's seminar room, the students participated in an interactive playful digital storytelling experience. They were invited to assist a digital agent, in the form of an avatar, like an online tutor, on the quest through a series of 3D Virtual Immersive Learning Environments (3D VIEs). The display was visible by all students via a video projector. With the help of this tutor-avatar, which was controlled by a LIC instructor, children traveled back in time and visited simulated 3D virtual environments. The realistically constructed virtual environments allowed students to immerse themselves experiencing aesthetics, architecture, clothing and the culture of that time. Moreover, the students explored cyber-spaces, observed online historical samples and experimented with interactive objects related to the respective studied technological advancement

Figure 1. Playful Library Tour: Students searching for books

or milestone. At the same time, appropriately timed soundtrack was woven into the story to enhance the emotional depth and feeling of immersion. This particular activity highlighted the following milestones about the history of the book:

- Storytelling and ancient cave drawings ca. 32000 BC
- The invention of writing and ancient clay tablets ca. 3500 BC
- Linear A & B script ca. 1450 BC
- The invention of the alphabet ca. 1200 BC
- Papyrus and the Great Library of Alexandria ca. 200 BC
- Byzantine/Roman Scriptorium and the systematic copy of manuscripts in monasteries ca. 600 AD
- The invention of the movable type ca. 1040 AD
- Modern Library ca. 1980 AD
- Tablets and e-books ca. 2014 AD

Herein, concepts and principles from the Problem-Focused Education paradigm played an important role to form a learning innovation: In order to motivate students learning we particularly used contextualized problems and designed interactive elements in the learning activity. At each stop, students were encouraged to demonstrate their (updated) knowledge, conceptual understanding, and critical, creative and reflective thinking skills related to each milestone through age-specific questions and quizzes. For example, in the Ancient Greece stop, the students of the second and third grade played a mini-game, where they had to guess the modern equivalents of the ancient Phoenician alphabet letters. Also in the Space Age stop we challenged the students of fifth and sixth grade to find a solution for the storage of the ever-increasing volume of books and knowledge production.

The students were divided into two groups so as to actively participate in the game that required two teams. Each team scored a point when they were able to answer questions or make valid and useful observations around each milestone. The duration of the storytelling activity was 45 minutes.

An example of the above game activity was the Phoenician Alphabet Challenge, designed for students of 2-6th grade. The two student teams were challenged in turns to identify the correct temporary letter by observing a matrix of selected Phoenician letters.

During the third project stage, students were divided into small groups of three to five pupils. After a brief demonstration of the tablet's use, each group had the challenge to demonstrate their reflective and creative thinking; discuss, experiment with the tablet's software, decide and collaboratively create digital artifacts inspired by the previous book history experiences (see Figure 3). The creative task had duration of 30-40 minutes. These groups used simple multimedia and image editing software of a modern tablet to produce completely diverse digital artifacts (see Figures 2 and 4). The tablets were leased to LIC temporarily by the University of Patras' Human - Computer Interaction Group. The best drawings from each school were showcased on LIC's website.

5. SOCIO-TECHNICAL DEVELOPMENT AND LEARNING MOTIVATION

For the second project stage, we needed to use appropriate 3D virtual immersive environments (3D VIEs) that we either designed and produced or adapted from existing 3D VIEs in the platform of Second Life. The new 3D VIEs were developed at a cost-effective manner in-house by the LIC's 3D Virtual Worlds Expert and first author of this paper in the University of Patras' space in Second Life. The existing 3D VIEs were used and adapted temporarily with permission by their creators and administrators. In total, the following 3D VIEs were used during the experience:

- Lascaux France prehistoric cave (see image 3)
- Ancient Babylon & Mesopotamia

Figure 2. Students' drawing (2th grade): "Phaistos Disk", the first typography system in history

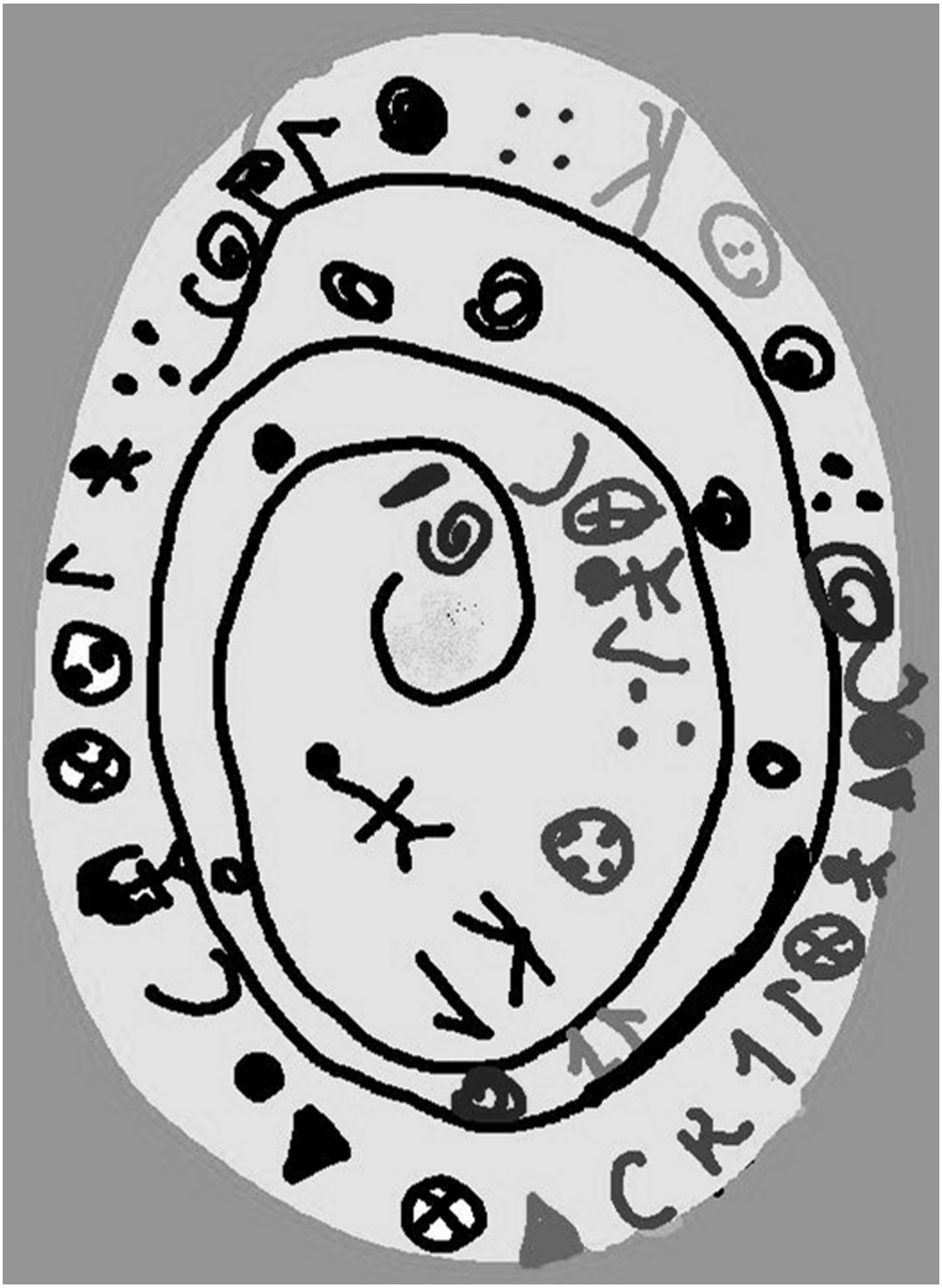


Figure 3. Collaborative creative group reflection activity using tablets

- Ancient Greece
- Ancient Egypt
- Byzantine monastery
- Typography machine
- Space age

The visited 3D VIEs were placed in or adapted from the following islands in Second Life:

- University of Washington's Museum of Virtual Media
- Museum Island
- Alice Academy
- Ancient Alexandria
- International Spaceflight Museum

The 3D VIEs essentially contributed to the students' learning experiences in the following ways, since there was evidently clear that they:

- Depicted the civilization's architecture, natural environment and aesthetics
- Showed clothing and appearance of a representative of each milestone (through the avatar's clothing and skin)

Figure 4. 3D VIE Ancient Egypt & avatar appearance in Second Life

- Visualized objects and notions not available in the physical life, e.g. the arrangement of scrolls in the Great Library of Alexandria
- Demonstrated through programming how inventions worked (e.g. movable type)
- Included objects to be used as prompts during the game (e.g. the Phaistos disk)

The role of the avatar (Yee & Bailenson, 2007) was also equally crucial to the design of the learning experience as it contributed to an additional playful element beyond its functional role in the 3D VIEs and influenced interaction and motivation positively and evidently. Through the use of appropriate animations, the digital agent responded to students' questions and answers, action suggestions or other surprise events in the storyboard, demonstrating emotions and sound effects. This rather non-anticipated behaviour was a surprising element that understandably entertained the students widely and provided a flair style of an interactive show during the motivated learning experience (see also Figure 5).

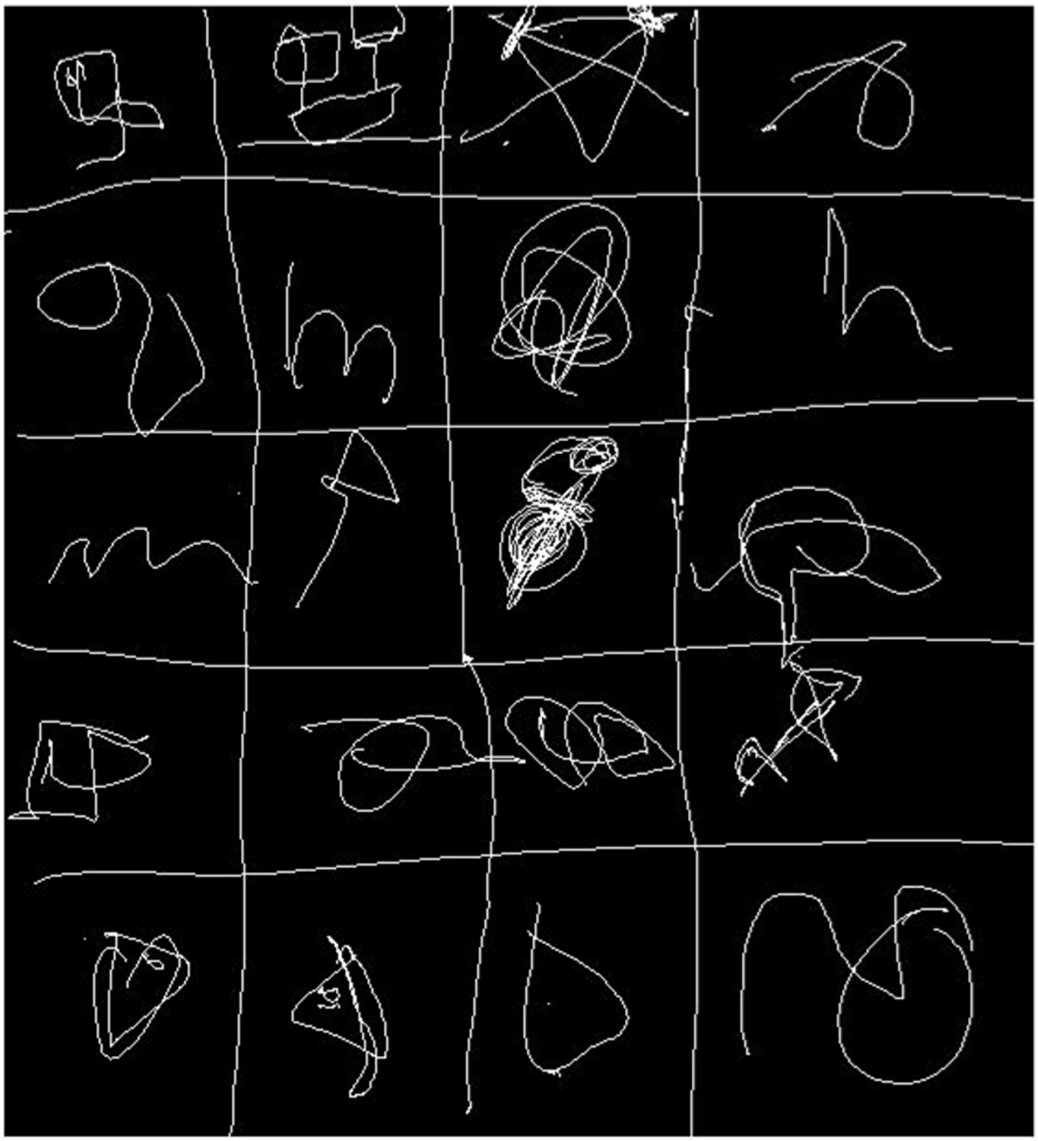
6. CONCLUSION AND FUTURE RESEARCH AND DEVELOPMENT

Storytelling can be used to develop and demonstrate educational aims in practice. Modern digital media can complement traditional ways of learning by creating new ways for learners to experience and remember stories and associated information and knowledge.

As this was a pilot, but also an ongoing research project, we hereby only present and reflect on some initial findings and outline research limitations, general skepticism and future steps.

Tools for team collaboration can provide an assisted to learning environment for early age learners. Online games and other ICTs, such as those used in our pilot project can digitalise innovative learning through interactive fiction or participative storytelling. They can further enhance curiosity and stimulate learning by involving the user in interesting virtual worlds that resemble real facts, events and other knowledge.

Figure 5. Students' digital artifact (4th grade): "Ancient Mesopotamian tablet with symbols"



At the end of the project's last stage, the teachers were called upon to evaluate the learning experience's design, layout and activities, as well as the interaction, reactions, behaviour, emotions and performance of their students. For this data collection, the teachers first completed an online questionnaire. The questionnaire was designed considering the 5 responses-preferences of Likert scale (Cohen et al., 2007).

There were twenty-eight (28) teachers who participated in the current evaluation study and responded to the questionnaire. In summary, the initial findings from this questionnaire's data collection suggested the following: 81% of the teachers confirmed that children acquired new skills (with answers: 'agree' and 'fully agree'); 85% affirmed that the learning experience added to the students' positive mentality towards books and reading; 85% of the teachers estimated that the learning

experience helped children to assume a positive attitude towards books and reading (answers: agree & fully agree); 98% found 3D VIEs useful for facts recalling and history understanding.

During the qualitative research evaluation phase, through the unstructured interviews (Cohen et al., 2007), among other comments (Mystakidis et al., 2014) the teachers expressed, among other, the following opinions, which range from the very optimistic and positive to more skeptical ones:

I have never seen my class so quiet and concentrated as when they attended this program.
You exceeded teachers' and students' expectations; you have captivated children's interest and they enjoyed the program greatly. The whole visit to the Library was so alive.
I am not sure if the use of technology will increase my students' desire to read books.

Overall, 3D Virtual Immersive Environments combined with engaging pedagogical methods such as scaffolding (Chase & Scopes, 2012) enabled LIC to produce a cost effective and yet rich learning experience in cyber-space; and engage students from local schools, which could not otherwise have because they would not afford to travel to the actual physical places. Utilizing the socio-psychological power of the avatar image, the visualization and simulation affordances of 3D virtual immersive learning environments and the appeal of storytelling and game-based learning, LIC designed and developed a "gamified" blended narrative on the evolution of the book, where learning is embedded and context-enabled.

The "From the Ancient to the Modern Tablets" programme was a pilot educational project intended to serve as a proof of concept and the first step towards the formulation of a new pedagogical framework design with the essential and tried epistemological concepts for a full-scale project implementation.

Due to resources scarcity it was not possible to organize a true random sampling (Cohen et al., 2007) by inviting truly representative school classes to participate in the project. However, the geographical distribution of the visiting schools was representative enough as it included classes both from urban and rural areas, but also from areas of high and low income. In any case, the results could be skewed when we take into account the degree of interest and initiative by teachers and head teachers to provide optional learning opportunities by participating in the pilot study programme.

In the next phase of our research and development project we intend to conduct a research study in the form of an experiment or quasi-experiment so as to capture in greater detail the effectiveness of 3D Virtual Immersive Environments on students' skills in the socio-cognitive, psychomotor and affective domains. Also, a notable contribution to this study would be the immediate (just after the experiment), short-term (a few days/weeks after) and long-term (a few months/years) feedback from the students-learners themselves; this feedback aspect is missing, at the moment. The collection of this data could provide invaluable insights for the personal learning processes and self-organised learning skills.

This informative educational student-centred programme has been popular among schools. The programme's high engagement level created enthusiastic students' responses and positive learning behaviours. This project also became known and well-accepted among teachers. More than 1,500 students from twenty (20) schools (ages: 7-15) have participated in and learned about typography and the history of the book and its future, in innovative learning ways and advancing their knowledge and skills through edutainment (education + entertainment).

Critically speaking, the gap between those who enjoy the learning environments with the benefits of new technologies and those who do not is a major societal concern, often associated with phenomena of social exclusion. New media technologies, if accessed, have the (not yet fully realized) potential to assist people facing unequal learning opportunities often because of economic inequality, geographic and social discrimination and cultural misrepresentation (Reed, 2017).

Information seeking and finding in creative collaboration ways and enquiry-based/problem-focused education approaches have been encouraging pedagogical frameworks and proved to be very fruitful in combination with game mechanics in 3D Virtual Immersive Learning Environments.

A further future research and development target of this ongoing project is to accommodate these pedagogical concepts within an epistemological framework that considers social inclusion and promotes deep learning strategies. There are different requirements for the latter, and access to these new media, both within and between countries would highlight the differences in the learning process and learning outcomes. Any inequalities, often referred to by the term "digital divide", involve both questions of access (who is online) and representation (what is online and how truly does it reflect the diverse digital world cultures (see e.g. Reed, 2017). In the future of this research and development project we prioritized our investigation on issues of inclusion and digital divide, digital learning identities and multicultural representation and deep/surface learning comparison within the framework of problem focused education.

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