

Playful Creation of Digital Stories with eShadow

Game-Like Cross-Curricular Learning inspired by Traditional Greek Shadow Theatre

Argyro Moraiti, Nektarios Moumoutzis, Marios Christoulakis, Andreas Pitsiladis,
George Stylianakis, Yiannis Sifakis, Ioannis Maragoudakis, Stavros Christodoulakis

Laboratory of Distributed Multimedia Information Systems & Applications, School of Electronic & Computer Engineering
Technical University of Crete, Chania, Greece

argyro.moraiti@gmail.com, nektar@ced.tuc.gr, christoulakis@ced.tuc.gr, pitsilad@ced.tuc.gr,
gstylianakis@ced.tuc.gr, i_sifakis@hotmail.com, imarag@ced.tuc.gr, stavros@ced.tuc.gr

Abstract— eShadow promotes a new way of dramatized and personalized digital storytelling inspired by the rich tradition of shadow theatre. It enables game-like interventions combining several digital tools for the production of digital stories covering all five phases of filmmaking: scenario development, pre-production, production, post-production and distribution. eShadow can be used (a) to create digital shadow puppets, and (b) to set up, perform and record the scenes of the digital story (production phase). This way, digital story creation is wrapped around interesting game-like decisions, playful improvisations and creative learning. eShadow has been extensively used to support cross-curricular learning mainly in Greek schools. It is currently extended to support marionette-like interactions to promote its use in countries with relevant storytelling cultures.

Keywords—digital storytelling; shadow theatre; cross-curricular learning; playful learning

I. INTRODUCTION

Shadow theatre is a storytelling tradition using flat articulated puppets which are held between a light source and a translucent screen or scrim. The cut-out shapes of puppets may include translucent color or other types of detailing. Shadow theatre is popular in various cultures in more than 20 countries, mainly in Asia. In Greece it used to be very popular at the end of the 19th and beginning of 20th century in both urban and rural areas. Although its popularity declined as cinema and TV invaded the Greek society, it still remains a favorite entertainment for many children and adults and a way for personal expression as a means of dramatized storytelling.

Shadow theatre is a medium with significant educational value [1] within the wider context of drama and performance arts. This is linked to the ability of shadow theatre to activate people and promote their creativity as they engage in diverse activities during the preparation and the actual performance of shadow theatre plays. In particular children and adults find their own ways to act and imitate, create dialogues, get inspired and convey their own messages, direct, become stage designers, sing, strengthen their self-confidence giving life to the puppets, improvise and create their own stories. Thereby they cultivate their oral speech skills and develop in multiple modes their intelligence (multiple intelligences) in an entertaining manner. In addition, they get familiar with the creative inquiry-based process of scenario development and subsequent artistic work to prepare puppets and sceneries

employing painting and handicraft. Finally, they are given the opportunity to discover identities of peoples and regions through the musical, linguistic and cultural particularities of certain shadow theatre characters.

The digital version of shadow theatre enriches traditional features with digital technology elements: It enables the production of rich multimedia content interactively using innovative input devices and supports online collaboration. Eventually, eShadow shapes a rich pedagogical framework for cross-curricular learning combining tradition and technology in a compelling manner. It incorporates game features that foster learning [2] in a way that highlights the connection between digital storytelling and playful learning interventions.

In the following sections, the concept of cross-curricular learning is presented first (Section II) emphasizing on thematic project-based learning. Section III presents eShadow, its architecture and technical aspects. Section IV presents the wider framework for creative learning, which is supported by eShadow. The framework is based on the phases of the filmmaking process and constitutes a flexible learning environment that can be adapted to different educational needs by selecting the activities/phases that are significant in each specific situation. Section V presents evaluation results and indicative examples of digital stories created with eShadow. Section VI discusses the main conclusions drawn from the extensive use of eShadow in schools and outlines future plans.

II. CROSS-CURRICULAR LEARNING AND STORYTELLING

In recent years, cross-curricular learning constitutes an important parameter for educational innovation: It enables teachers and students to transcend the boundaries of distinct disciplines and engage in learning experiences combined, in many cases, with approaches that exploit playful inquiry-based learning and storytelling as a means to promote deep learning through the engagement of students in the creation of their own artefacts [2]. Cross-curricular learning involves a conscious effort to apply knowledge, principles, and/or values related with two or more disciplines within a rich pedagogical ground. The unifying framework may be based on a central theme, issue, problem, process, topic, or experience [3].

Cross-curricular learning seeks to confront major problems in education related to the prevalent mode of fragmented and isolated skill instruction. It enables students to think and reason by providing opportunities for authentic learning [4][5], i.e.

learning that is linked to their own interests and lives. This way students can transfer knowledge learned in one context to other contexts in and out of school [6]. Due to its special attention to authentic and integrated learning activities, this type of learning is reported to increase students' motivation for learning and their level of engagement [7].

The ideal way to implement cross-curricular learning is through thematic units. Thematic units offer teachers a meaningful and flexible organizational framework for cross-curricular learning [8]. Within a thematic unit, teachers have the possibility to integrate content area activities and engage students in meaningful deep learning experiences [9]. Themes may be focused on a specific subject area, or they could be related to a general topic that represents a horizontal aspect of the learning process. For example, the focus of a theme may rely on a certain storytelling genre, such as mythology or folk tales. The learning activities, then, may be related to the development of a story around the selected theme that is linked to learning objectives of multiple curricula subjects (e.g. environmental-oriented stories linked to sciences and local history). Thematic units may also relate to global topics (e.g. conflict/cooperation, economic problems, war and peace etc.).

It is important to note that the primary school curricula in Greece give significant importance to cross-curricular learning. In particular, the Cross Thematic Curriculum Framework for Compulsory Education (CTCFCE) was established in Greece in 2003 and supplemented the Curriculum Framework (CF) of 1999. With CTCFCE teachers were given greater flexibility and freedom of initiatives regarding the cross-curricular approach of knowledge. As noted by Kouloumparitsi [10] CTCFCE implements cross-curricular learning in three ways: (a) the intra-sectorial/intra-branch consistency within each discipline, (b) the inter-sectorial/inter-branch correlations among disciplines, and (c) with the theme-centered applications which are the optimal form of cross-curricular learning as theme serves as the organizational focus of the learning process. The theme may be an original problem, a question related to broader social values, moral dilemmas, experiences, etc. During theme editing, students along with the teacher's support, undertake various activities and build knowledge and skills associated with individual disciplines. Thus, the students creatively get accustomed and process what traditionally consists the "curriculum". This is not done in an isolated and abstract fashion, as in traditional school learning, but in relation to the specific theme and the needs arising during theme processing. Consequently, students discover and transform knowledge through active involvement, beyond the role of passive receiver of information as it is the case in traditional learning settings where the emphasis is given in memorization and accumulation of information. Further, Kouloumparitsi [10] notes that cross-curricular learning is associated with horizontal skills-literacies of universal nature that are present in all disciplines: language, mathematics, social skills, sciences, ICT, and problem solving.

III. ESHADOW AND ESHADOW EDITOR

eShadow provides a playful storytelling environment with unique features and realistic motion simulation of shadow theatre's puppets (Fig. 1) that is based on a physics engine.

Realistic movement provides an explanation for the popularity of our platform among Greek teachers and students as revealed during the field trials as well as during testing with actual professional performers [11]. Furthermore, realistic movement of digital puppets creates an atmosphere of playful interaction where the users are very easily engaged in theatrical improvisations that can be very important, especially for children of small ages, to develop their abilities for oral expression and interpretation of body language.

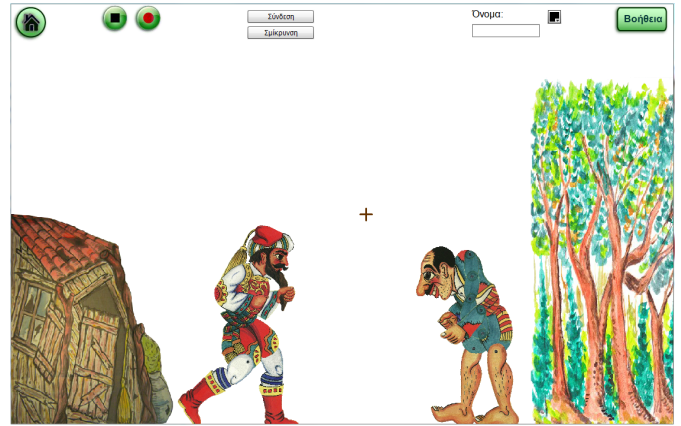


Fig. 1. eShadow showing a scene with two puppets and two scenery objects.

Moreover, eShadow extends traditional shadow theatre by enabling collaboration not only locally but also from distance. Thus, children from different physical locations can engage in role-playing game-like activities when preparing their stories or just for the fun of improvisation. This kind of role-playing interaction can be interesting between children and adults as well: Adults can impersonate favorite heroes to engage children in playful creative interactions. This resembles traditional shadow theatre dialogues between Karagiozis and other characters before the main part of a performance.

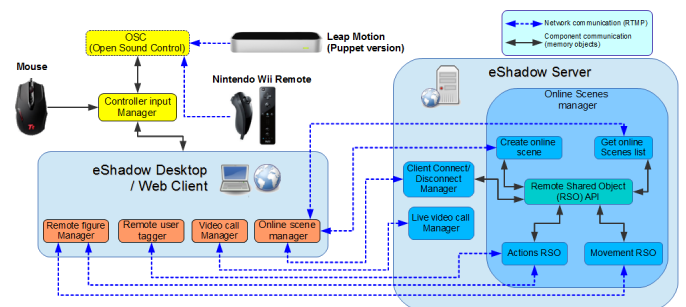


Fig. 2. eShadow client-server architecture and input devices.

eShadow offers both a desktop and a web application. Several input devices can be used to control the digital puppets including the computer mouse, a motion recognition controller such as Nintendo's Wii Remote [12] or any device supporting the Open Sound Control standard. Collaborative performance online is supported to record individual scenes, store and combine them in playlists. Each remote client communicates with the eShadow server (Fig. 2) that handles coordination between clients so that all clients see the same scene with the movement of digital puppets synchronized.

Significant importance has been given to eShadow's usability as it targets users ranging from young children to parents and teachers. Throughout the system development usability tests were conducted with real users. The results derived were then analyzed in order to extract requirements for the continuous improvement of eShadow's usability and functionality. Widely accepted methodologies were used for the evaluation of the whole system [11].

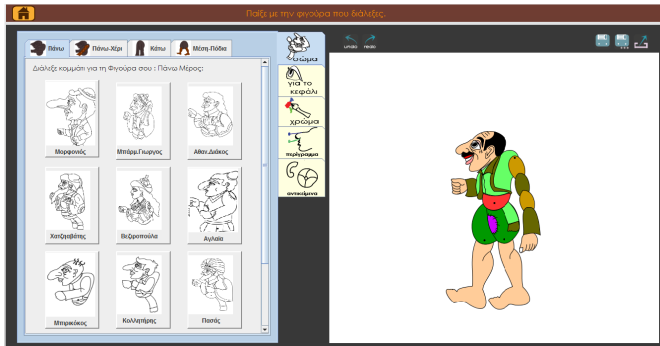


Fig. 3. Remixing a digital puppet in eShadow editor.

A special desktop application, namely eShadow editor, enables creation of digital puppets. Significant emphasis has been given on the usability of this application as well by using similar software development methodologies [13] as in the case

of eShadow. eShadow editor provides a playful environment (Fig. 3) where children can remix digital puppets in many ways: by painting, changing the appearance of their faces, combine different body parts and use various accessories such as hats and hand-held objects. Digital puppets can be stored for further editing or exported to eShadow to be used in actual scenes and improvisations.

IV. DIGITAL CONTENT PRODUCTION WITH ESHADOW

eShadow embraces the most inclusive flavor of cross-curricular learning through thematic units in order to bring forward the educational innovations discussed in Section II. Within a certain theme, usually selected by the teacher, students create their own digital stories. This approach is based on research findings [14] that point to digital storytelling as a valuable, transformative tool for learners in a range of curriculum and discipline contents (i.e. cross-curricular). To this end, a learning design based on the stages of filmmaking [15] is promoted enriched with the necessary pedagogical elements that take into account the optimum level of granularity needed before subtle variations in learning approaches can be meaningfully communicated. As Kearney [14] notes: *“representation of designs in domains such as filmmaking need to use carefully selected language and clearly communicate principles to an audience from a potentially wide*

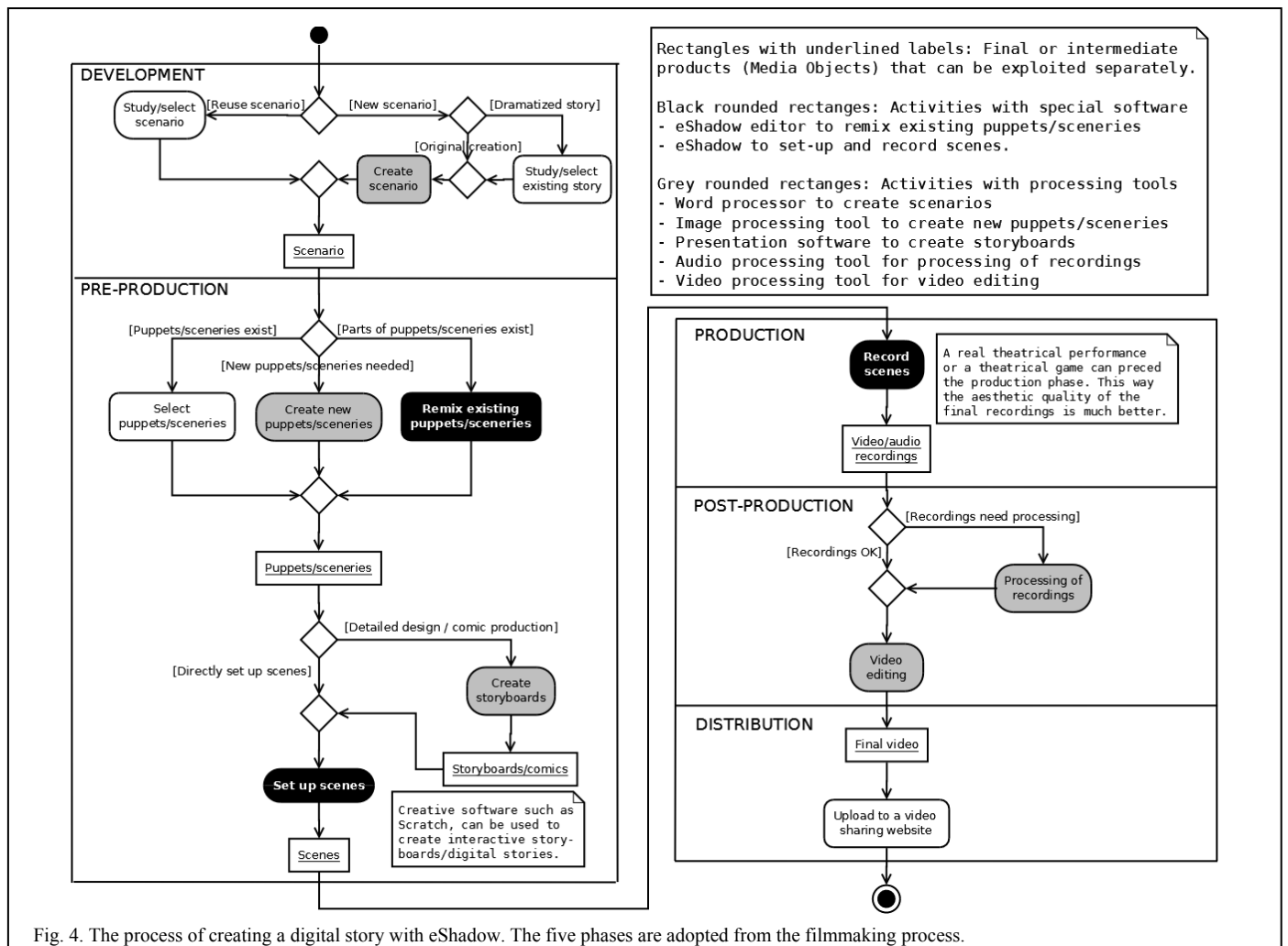


Fig. 4. The process of creating a digital story with eShadow. The five phases are adopted from the filmmaking process.

range of disciplinary backgrounds. Finally, designs involving rapidly changing technologies such as digital video are essentially fluid and dynamic in nature and regular revisions are needed to explore and document future pedagogical developments". This "fluid" and "dynamic" nature of digital video is indeed the case for our approach where there is a need to use special software to simulate as realistically as possible the aesthetics and animating characteristics of shadow theatre.

Following Kearney's findings [14], the filmmaking process is adapted in a flexible game-like manner: The process begins with script writing or selection of an existing script. Playful interventions are also possible: The teacher could offer a (possibly partial) story or a set of story elements and ask students to dramatize it. This may be combined with inquiries to research actual historical events or other facts and link them to persons that will become the main characters of the story. Second is the pre-production phase that includes selection or creation of digital puppets and sceneries, articulation of story scenes and detailed design via storyboards (optional). Third is the actual production (scenes recording). The post-production phase includes audio processing (optional) and video editing to produce the final digital story. The fifth and last phase is the distribution (sharing) of the digital story.

Figure 4 illustrates the 5-stage creativity process wrapping eShadow and eShadow as an activity diagram that highlights tasks and external tools employed. It is a modular process that allows the selection of activities/tasks that will be carried out by the students of a specific class and enables alternative implementation options. For example, script writing could be skipped if an existing script is used. Existing digital puppets and sceneries can also be used instead of creating new ones. Post-production can be skipped in lower grades, where pupils lack skills to work with the corresponding tools or when classroom time is limited. In such cases audio processing and video editing can be done by the teacher or external partners.

It is worth pointing out that the whole process can be enriched with additional activities depending on teacher's goals, students' interests of students and time available. These additional activities could further enhance the creative, game-like and personalized nature of the approach by introducing the use of creativity platforms beyond eShadow or address issues on how stories can be adapted to students' prior knowledge, ways of learning and misconceptions to promote deep learning. Indicative enrichment activities include: (a) utilization of a creative programming platform, such as Scratch [16] for creating interactive storyboards or an alternative form of the digital story in interactive form; and (b) preparation of a theatrical performance or theatrical games that enable students to practice the spoken word articulation and the kinesiology of the performance.

V. EVALUATION AND ACTUAL USE

Two field trials have been undertaken to evaluate the usability, user acceptance and educational added value of eShadow. The first trial addressed school students of grades K-3 and above. The second one addressed kindergarten and lower primary school grades (K-1 and K-2). Both trials were organized the same way with different feedback questionnaires.

During the trials, students first watched a digital story prepared with eShadow. After that they got the text script divided in nine scenes and formed groups with 2-4 members each. Every group used eShadow to perform and record a certain scene without any help beyond a short demonstration on the use of input devices to control the digital puppets. Due to technical limitations the maximum number of digital puppets that could be controlled simultaneously was two. If the team consisted of more than two members, the students that did not control digital puppets were voice acting. Every group had the option to improvise instead of recreating one of the nine story scenes. Finally, the students filled a questionnaire:

1. For the first trial the questionnaire used was an adapted version of QUIS, which is a standard user satisfaction measurement tool [17]. It contained 25 rating questions (0-9) to evaluate the creativity features and usability aspects of eShadow. In total 47 students filled this questionnaire. The questionnaire reliability was validated using the Cronbach's alpha metric and was found acceptable (0.908).
2. For the second trial emoticon cards [18] were used taking into account that most children up to grade K-2 cannot read fluently and, thus, the QUIS-based questionnaire would be inadequate. In total 61 filled questionnaires were collected.

The results of the first trial are shown in Table I. It is clear that in all questions concerning the added value and educational potential of eShadow as a creative platform as well as its usability aspects, the students responded with high ratings. All mean values are above 7 with only one exception for question Q03 (Mean=6.76). More than one third of the mean values (9 out of 25) are greater or equal to 8.

TABLE I. FIRST TRIAL RESULTS WITH 95% T-CONFIDENCE INTERVAL

Q	Question	Mean	Stand. Error	95% C.I.
01	I would create a story for personal expression 0-9	7,09	0,33	±0,67
02	I would create a story to share with friends 0-9	7,55	0,30	±0,60
03	I would create a story to transmit a message 0-9	6,76	0,40	±0,81
04	I would create a story to share what I learned 0-9	7,38	0,32	±0,63
05	I would watch stories created with eShadow 0-9	8,36	0,19	±0,37
06	eShadow can be used for learning 0-9	8,02	0,20	±0,40
07	Interacting with eShadow: difficult (0) – easy (9)	7,72	0,25	±0,51
08	Help messages: unhelpful (0) – helpful (9)	7,48	0,29	±0,58
09	Becoming an expert user: disagree (0) – agree (9)	7,43	0,32	±0,65
10	Easy to use: disagree (0) – agree (9)	7,91	0,24	±0,49
11	Reading the screen: difficult (0) – easy (9)	7,83	0,37	±0,75
12	Screen organization: confusing(0)–very clear (9)	8,33	0,19	±0,37
13	Screens sequencing: confusing(0) – very clear(9)	8,26	0,19	±0,38
14	Adequate terminology: never (0) – always (9)	7,98	0,20	±0,40
15	Messages' placement: confusing(0)–very clear(9)	7,91	0,19	±0,37
16	System state notifications: Never (0) – always (9)	7,69	0,28	±0,56
17	System speed: slow (0) – fast (9)	8,04	0,18	±0,37
18	Problems encountered: many (0) – none(9)	8,00	0,33	±0,67
Overall reactions to the system:				
19	Terrible (0) – wonderful (9)	8,62	0,08	±0,17
20	Frustrating (0) – satisfying (9)	7,89	0,30	±0,61
21	Dull (0) – stimulating (9)	8,17	0,28	±0,56
22	Difficult (0) – easy (9)	7,41	0,32	±0,65
23	Rigid (0) – flexible (9)	7,76	0,30	±0,60
24	Learning the system: difficult (0) – easy (9)	8,04	0,24	±0,48
25	Doing desired task:difficult (0) – easy (9)	7,93	0,24	±0,49

Fig. 5 provides a box plot of the ratings. It is evident that most ratings are very close or above the mean values already shown in Table I and depicted a crosses in the plot. There are few exceptional very low ratings that could be considered as outliers (small circles in the plot). It is worth noting that the majority of ratings are above or equal to seven (7) for all questions. Consequently, we could safely infer that the trial results clearly show high user acceptance, thus demonstrating the potential of eShadow. Furthermore, eShadow successfully communicates to students its educational value as a creative platform (questions Q01-Q06) and provokes positive reactions (Q19-Q25) especially regarding its stimulating nature (Q19).

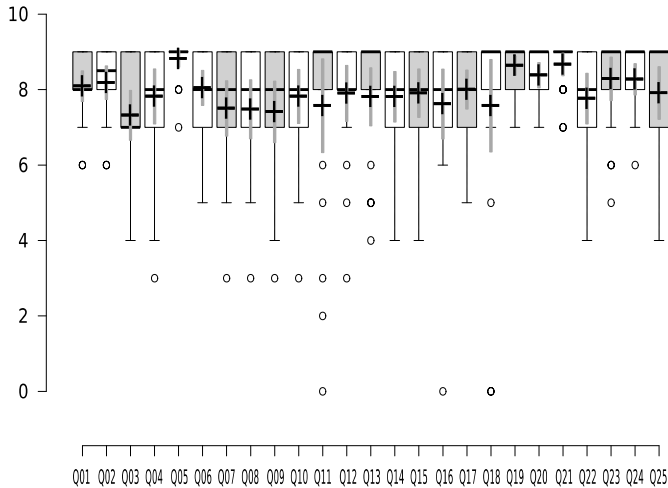


Fig. 5. Box plot of questionnaire responses. Mean values shown with crosses.

Fig. 6 depicts the results of the second trial evaluating the emotional response of younger children. These results are very positive as well showing that the vast majority of the children responded with excitement and pleasure to eShadow.

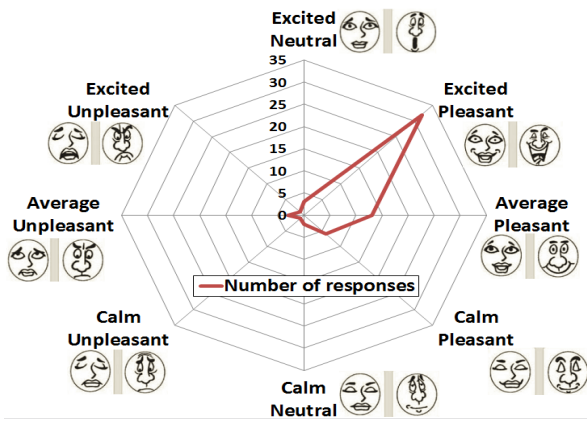


Fig. 6. Evaluation of emotional response using emoticons.

Following those promising trials, several interventions in more than 50 Greek schools (mainly in Crete) were organized following the cross-curricular learning framework already presented (Fig. 4). Table II provides an indicative list of digital storytelling projects that were implemented. Furthermore, eShadow has been used in a 3-month joint project among remote schools in Greece to support the preparation and the implementation of a musical online event entitled “Akriton Mousiki” [19]. This case does not refer to the development of a

digital story. In this setting, eShadow was used to support real-time communication between the students of the participating schools: Students collaborated synchronously via eShadow to prepare and implement the event (in combination with a videoconferencing environment) animating their own digital puppets in synch with the music performed.

TABLE II. INDICATIVE DIGITAL STORIES DEVELOPED WITH ESHADOW

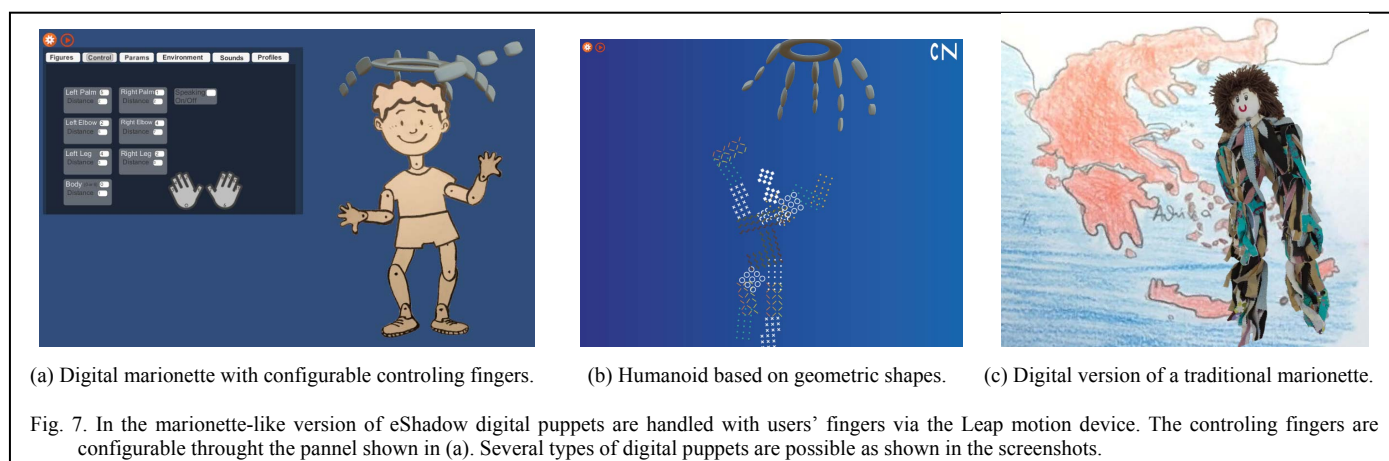
Title/topic	Description and link
Karagiozis and econ.development	Environmental story. Scenario & voice: Nikos Blazakis https://youtu.be/AjgbXNhj-8
Summer vacations	Original scenario. Primary School of Agia Chania https://youtu.be/adZJzcU6emQ
Karagiozis show	Original scenario. 10th Primary School of Chania https://youtu.be/iDlsHSgkOaI
Karagiozis and the Ecofans save the forest	English-speaking environmental project Greek-American Union Ecofans club. https://youtu.be/VB_in0WkG1Y
Karagiozis and the IMF	Original scenario. 9th Primary School of Chania. https://youtu.be/JXP-3ruCrvC
Karagiozis as a baker	Based on traditional scenario. Theodoropoulos School. https://youtu.be/oNzyYCnSUVQ
Pato dialogues	Philosophical discussions. 19th Primary School of Chania. http://goo.gl/EmWKZM
Safer Internet contest projects	Original scenarios. Indicative list: 19th Primary School of Chania- https://youtu.be/dkbwT6QMrfA Mourmies Professional Lyceum- https://youtu.be/Fp8tMhP_iM 2nd Gymnasium of Pyrgos- https://youtu.be/CqutEGacMtg
Kolitiri learns to solve algebraic equations	Based on an original scenario of Mrs Mary Galani. Gymnasium of Platanias. https://youtu.be/HTDji0FPsto

Finally, a new version of eShadow is under development on the Unity 3D game engine. A LEAP motion controller [20] is used to control digital puppets with fingers, thus simulating traditional marionettes (Fig. 7). The aim is to enable real-time interaction with digital puppets in cultural events organized by the Caravan Next EU project. A prototype of this new version was used during a pilot school project by K-4 grade students to create a story (available at: <https://youtu.be/hc4-FZ4BLmo>) where a rug-made marionette (Fig. 7c) presents EU countries.

VI. CONCLUSIONS AND FUTURE EXTENSIONS

eShadow renovates shadow theatre tradition by employing Internet technologies and interactive graphics to offer a creative digital platform in tune with current trends of cross-curricular learning. It enables people to engage again with their national culture in a way that combines ICT in a creative and educationally significant framework. Through the use of ICT students undertake various roles, cultivate social and cognitive skills while developing their psycho-emotional world. The web application version of eShadow is freely available from <http://eshadow.gr>. The site links to digital stories created with eShadow and also offers information (in Greek) about the desktop version and how it is installed and used.

eShadow promotes playful learning scenarios that motivate and entertain children. It supports an inclusive learning framework that enables teachers to design and implement interdisciplinary theme-centered projects showcasing intra- and inter-sectorial/branch correlations in a variety of subjects (language, history, music, computing, etc.). The framework adopts the phases of the filmmaking process in a flexible way to promote cross-curricular (horizontal) skills: speaking and



writing skills, social cooperation and research skills, digital and metacognitive skills.

The use of eShadow in school, as it was observed, motivates students that may be hyper-active or have a negative attitude towards school. Throughout the story creation process all students exercise group work and construct valuable social knowledge and mutual understanding. Carefully selected themes encourage comprehension of concepts that are hard to understand such as abstract mathematical notations. For instance, the story entitled "Kolitiri learns to solve algebraic equations" demonstrates an intuitive approach to model algebraic equations and the steps for solving them using a weighting machine. Stories like this can be further used as learning material for lower grades' students.

Future plans are linked to ongoing work related to the use of arts to foster creativity and deep learning in all school subjects within the context of the Erasmus+ e-ARTinED project. This line of work seeks to mainstream initial results of using eShadow in topics related to language, mathematics, science and environmental education to a European context.

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