Analysis of Educational Digital Storytelling Software of the last five years: Use of the "Dimension Star" Model

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Abstract: Storytelling has been around since the beginning of time, rooted in our human culture. However, its modern successor, digital storytelling (DS) is a very recent experiment. For the evaluation of Educational Digital Storytelling Environments (EDSE) a few models were developed, helping in the categorization of EDSE. A useful, comprehensive and representative evaluation model of EDSE is the "Dimension Star" [Schafer et.al 2004] which evaluates EDSE with twelve criteria-dimensions. In this paper, we will analyze EDSE of the last five years and evaluate them with the "Dimension Star" model. This study may help the researchers in the field of DS with a clear picture of the existent EDSE so that be able to make appropriate decisions for the design of EDSE. Finally, this study can help teachers to choose appropriate EDSE so that be able to fulfill specific teaching goals in their classrooms.

Keywords: educational digital storytelling environments, evaluation, "Dimension Star" model, analysis- evaluation

1. Introduction

Stories have been told as far as time allows us to remember. In fact, when the information is put into an interesting or exciting story people tend to pay much more attention for what is told [Rijnja et.al (2004)]. Examples of how powerful stories can be, are the Iliad and the Odyssey by Homer. He is one of the first storytellers of mankind and it is thought that the epics we know today are the result of generations of storytellers passing on the material. As we can see, education through storytelling has been tested successfully in almost all the history of mankind unlike formal education at universities and schools which is a relatively recent institution. Furthermore, narrative is a fundamental epistemic modality [Papadimitriou et.al (2003)], that is refers to the way a speaker / writer communicates his thoughts.

In the last years a new genre of storytelling was developed, the digital storytelling, carrying the tradition of cinema narration. Building on modern social and constructivist views of learning [Piaget et.al (1952), Bruner et.al (1960), Vygotsky et.al (1978), Jonassen et.al (1999)] DS is a great channel to apply these theories in practice. DS allows students to participate actively and not just be passive consumers in a society steeped in digital products [Ohler et.al (2006)]. Moreover, according to Di Blas (2009, 2010): (a) DS in an educational process helps students work in groups and strengthen the bonds between children in class, and at the same time between students and their teacher, (b) As far as digital literacy is concerned, students acquire several technological skills through storytelling, (c) Another social benefit is that creating digital stories helps the integration of disabled students or students with learning difficulties through taking with this opportunity an active role, and (d) Last but not least, a major educational benefit gained with DS, is the ability to narrate.

Nevertheless, DS in education is still in its infancy and much remains to be done so that the DS gain a strong foothold in every day educational practices. One fundamental step in this direction is the formation of appropriate technical and pedagogical evaluation models and standards of DS environments. In fact, the use of appropriate evaluation models will help researchers, software designers and educators to gain a clear picture of good and bad practices related to EDSE which will be invaluable for the use of existent and the design of next generation EDSE. A number of requirements which may serve as criteria for DS evaluation have been reported: Murray (1998) introduces three categories for the analysis of digital story applications: immersion, agency and transformation. Mateas (2000) presents a character-based evaluation approach in extension of Aristotle's model of drama. His approach provides design and technology guidance for the particular case of building interactive drama systems. Furthermore, Spierling (2002) takes a closer look at the author of interactive storytelling applications. She presents a four hierarchical level architecture for authoring interactive storytelling applications. Each of these levels provides a different degree of agency for the user in the development of a story. On each level the architecture consists of an engine and a corresponding model e.g. story engine and story model. The engine is responsible for driving the action on that level, while the model contains rules which define the procedure. Finally, Schafer (2004) has proposed an evaluation model –entitled "Dimension Star" model- of DS applications consisting of the following twelve dimensions: Concreteness, involvement, coherence, continuity, structure, cognitive effort, virtuality, spatiality, control, interactivity, collaboration and immersion. Shafer's model seemed as a more complete DS evaluation tool, thus, it was selected for the analysis and evaluation of EDSE of the last five years. This is the contribution of this paper. In the next section of this paper, the "Dimension Star" model will be analytically presented and then, it will be used for the analysis and categorization of the EDSE of the last five years. The paper ends with conclusions and future research plans.

2. "Dimension Star": an evaluation model for digital storytelling

All applications of DS have certain common characteristics. More specifically, the content of a digital story is either pre-defined or it is allowed to the user to create his own (*Concreteness*). Digital stories typically follow a conceptual *structure*. The structure shows whether the resulting narratives relate to the literary definitions of a story. The degree of conceptual structure has consequences in the *cohesion and continuity* of the story which show us the causal and temporal relationship between the elements of the story. It also affects the *cognitive effort* required to create a story. The presentation of a digital history varies depending on the degree of *virtuality* and *spatiality*. Spatiality indicates whether the objects in space and space itself play a role in the evolution of the story. Virtuality refers to the extent to which the activity of storytelling takes place in a virtual world. Moreover, there is an interest in the degree of *collaboration* between users, the degree of *control* that users have in the evolution of events and the degree of *interactivity* that is allowed by the software. Finally, *immersion* shows the extent to which the user is drawn into the story.

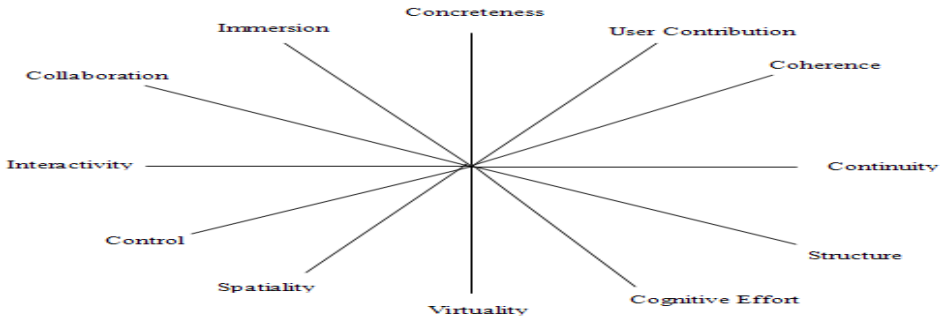

Figure 1. A diagrammatic representation of the "Dimension Star" model

The «Dimension Star», includes all the aforementioned features that may or may not have an EDSE (Fig. 1) and can be used as a model for the analysis of EDSE. The length of each peak is proportional to the features of each digital story. In fact, each feature is evaluated using a 4-grade scale (low, medium, high, very high) and the result is reflected on the length of the appropriate peak of the «Dimension Star».

3. EDSE of the last five years

A. *Toontastic*: Toontastic [Russell et.al (2010); Fig. 2(a)], is a collaborative digital animation creator that bridges the gap between game and more formal methods of storytelling. It is a constructive tool designed to help children capture and share their stories with other children around the world. It is designed to appeal to a broad group of users. As a drawing tool it is simple enough for six years old children and very

interesting to entertain adults. However, ages that it is primarily addressed are between eight and twelve. The aim of this software -that underlines its theoretical background- is to provide children with opportunities to outline their internal representations and convert them to external, with visual and physical representation, so that children are able to debug and rebuild their mental models.

B. *Kodu*: Kodu [http://research.microsoft.com/en-us/projects/kodu/; Fig. 2(b)], is a visual programming language which is used for the creation of digital games. It is easy to use and includes tools for creating three-dimensional worlds. Kodu is a multi-dimensional tool for digital storytelling with a variety of possibilities for creating digital stories. It is designed to be user friendly and accessible for children aged between 8-18 years. The creation of digital stories is made through the selection of appropriate characters and objects (e.g. character Kodu, trees, clouds, rocks etc.) that can be used in specific situations. Kodu helps children build a sound programming literacy without complicated programming concepts.

C. *Storytelling Alice*: Storytelling Alice [Kelleher et.al (2006); Fig. 2(c)], is a programming environment that introduces students to computer programming through the construction of 3D animated stories. Its main age target group is between 10 and 17 year old children. It's a variant of Alice which is an object-oriented educational programming language. Its emphasis on storytelling is based on the following three differences: i) Social interactions between the characters are possible through the programming of high-level animations. ii) Users are introduced to programming through building a story with the help of a story-based tutorial iii) A library with 3D characters and a scenery is existent so as to stretch users' imagination.

D. *Scratch*: Scratch [http://scratch.mit.edu/; Fig. 2(d)] is an educational programming environment designed from MIT in which novice programmers can express their creativity while promoting their computational thinking. Storytelling is a common use for Scratch as a method of personal expression. Students can create autobiographies, and various stories that give a new dimension to their interests and talents. Its target age group is between 6 to 16 year old children, but people of all ages can use Scratch.

E. *Fate2:* Fate2 [Garzotto et.al (2010); Fig. 2(e)], is a web-based, collaborative, multi-user digital storytelling environment. It is based on the Story Grammar theory [Propp et.al (1968)] which defines the morphology and syntax of stories. What is more, it provides a two and three dimension virtual space for children. The ages that Fate2 is mainly targeted are between 7 and 11 year old kids. It includes both educational and entertainment activities in order to increase engagement, emotion and motivation. Furthermore, it promotes collaboration through a shared WYSIWIS ("What You See Is What I See") environment in which users can be simultaneously connected to a network, thus synchronizing movements and object manipulation.

F. *JabberStamp*: JabberStamp [Raffle et.al (2007); Fig. 2(f)] is an EDSE in which users can embed their voices and ambient sounds in their drawings, paintings and collages. The main age target group for this EDSE is children between 4-8 years. In this age children's writing level is not high, however, in JabberStamp, they record the meanings of their drawings and compose a story that is based on their paintings. In Jabberstamp children draw in a typical paper and its main goal is to create the illusion that children's sounds exist within the paper page.

Figure 2. *(a)Toontastic, (b)Kodu, (c)Storytelling Alice, (d)Scratch, (e)Fate2, (f) Jabberstamp, (g)TellTable, (h)Wayang Authoring*

G. *TellTable*: TellTable [Cao et.al (2007); Fig. 2(g)] is an EDSE which helps children to create their own stories using objects such as digital photographs and drawings. These can be used to record a story which then can be played back. It runs on a multi-touch interactive table, based on Microsoft Surface™, which supports collaboration in both the development of characters and in the telling of stories. It combines the physical with the digital world, encourages children to free their imagination and promotes collaboration and self-expression by promoting sharing ideas among them. It is mainly designed for primary school children.

I. *Wayang Authoring*: Wayang Authoring [Widjajanto et.al (2008); Fig. 2(h)] is a web-based EDSE in which children from culturally diverse storytelling styles can create digital stories by using digital puppets. The idea of Wayang Authoring is based

on Wayang which is an Indonesian ancient form of storytelling. Wayang Authoring is composed of three elements: i) the imagination step that gives an inspiration to children through tutorials or pre-built stories, ii) the creative step in which children create and save their stories, and iii) the social step in which they can share, comment or even rank other children stories. The age group that Wayang Authoring is supposed to attract is 6-11 year old children.

4. Evaluation of EDSE using the 'Dimension Star' model

The EDSE described in the previous section were evaluated with the "Dimension Star" model. In fact, each of the authors of this paper individually used this model to evaluate the aforementioned environments. In terms of methodology, this study is a qualitative study which can be characterized as an 'expert review' study. This method may be classified as predictive evaluation [Squires et.al (1996)]. Despite the fact that, the use of a combination of various methods has been proposed for educational software evaluation, the use of expert review is also recommended as flexible, fast a cost effective method [Price et.al (1991)]. Specifically, each of the authors experimented with the features of each of the aforementioned EDSE in order to produce digital stories. During this experimentation each of the authors tried to make sense of how each of the dimensions of the aforementioned "Dimension Star" model is treated - within each EDSE- in order to measure them. The value of each of the twelve dimensions of this model is measured using a 4-grade scale [low, medium, high, very high (v. high)]. However, the authors collaborated in order to make an agreement, when their evaluation results were different. The authors also investigated the research literature related to the features of the aforementioned EDSE so that to compound in trustworthy results. The results of using the aforementioned method to evaluate the said EDSE are depicted in Table 1 and are briefly discussed below:

As far as dimension *Concreteness* is concerned, Kodu and Wayang Authoring take the highest value because the characters and the scenery are pre-defined in both of them. Toontastic, Scratch and JabberStamp receive the lowest value because user can create characters and scenery from scratch. As far as the dimension *User Contribution* is concerned, JabberStamp receives the highest value, because the user is given only a blank paper, so he must create every single feature of the story, while Kodu and Wayang Authoring receive the lowest value because all the graphics are predetermined.

In the dimensions *Coherence, Continuity* and *Structure* Toontastic receives the highest values because the elements of the story have a logical and temporal flow since the software helps the user build the story with questions in each step. What is more, the software helps the user with appropriate questions to create a well structured story. JabberStamp and Wayang authoring receive the lowest value in the three aforementioned dimensions because there is no tool or help from the software to lead you

to create a well structured story with cohesion and continuity. As far as the dimension *Cognitive Effort* is concerned, Kodu receives the highest value because users need considerable effort to familiarize themselves with the environment and create complex stories. On the other side of the coin, JabberStamp and Wayang Authoring are straightforward and very easy for the students to get acquainted with it.

Table 1. Evaluation of EDSE with the "Dimension Star" model

	Toon tastic	**Kodu**	**Storytelling Alice**	**Scratch**	**Fate2**	**Jabber Stamp**	**Tell Table**	**Wayang Authoring**
Concreteness (of the material)	low	**v. high**	**high**	low	**high**	low	medium	**v. high**
User Contribution (to the story creation)	**high**	low	medium	**high**	medium	**v. high**	**high**	low
Coherence	**v. high**	medium	medium	**high**	**high**	low	medium	low
Continuity (of the storyline)	**v. high**	medium	medium	**high**	**high**	low	medium	low
Structure	**v. high**	medium	medium	**high**	**high**	low	medium	low
Cognitive Effort	medium	**high**	medium	medium	medium	low	medium	low
Virtuality	**v. high**	**v. high**	**v. high**	**v. high**	**v. high**	**high**	medium	**v. high**
Spatiality	low	**v. high**	high	medium	**high**	low	medium	low
Control	**v. high**	medium	**high**	**high**	medium	**high**	**v. high**	medium
Interactivity	medium	**v. high**	**high**	medium	medium	medium	**high**	low
Collaboration	**v. high**	medium	medium	medium	medium	**high**	**v. high**	low
Immersion	medium	medium	**high**	medium	medium	low	medium	medium

All the EDSE apart from JabberStamp and TellTable receive a very high value in the dimension *Virtuality* because stories created take place entirely in a virtual environment. TellTable receives the lowest value among them because it is a mixed-reality EDSE that encourages children to play with physical objects and environments. As far as the dimension *Spatiality* is concerned, Kodu receives the highest value because the motion of objects in the three dimensional space of Kodu plays an important role in the evolution of each story, unlike Toontastic, JabberStamp and Wayang Authoring in which the impact of space is not important. In the dimension of *Interactivity*, Kodu receives the highest value because the user can interact with the characters and the objects of story during the creation and the presentation of the digital story. Wayang Authoring receives the lowest value because the minimum interactivity of the user with the environment and the characters is allowed. As far as the dimension

Collaboration is concerned, Toontastic and TellTable receive the highest value, because they both allow users to paint simultaneously the characters and the scenery of the story and promote collaboration by sharing and evaluating other children stories through the internet. On the contrary, Wayang Authoring supports only basic collaboration. Finally, in the dimension *Immersion*, JabberStamp receives the lowest value because stories are created in a static drawing that in no terms becomes a real space for the user. Storytelling Alice receives the highest value, because the users are immersed in its 3D environment.

5. Conclusions

Eight Educational Digital Storytelling Environments (EDSE), which were developed the last five years, were analyzed with the "Dimension Star" DS reference model, namely: Toontastic, Kodu, Storytelling Alice, Scratch, Fate2, JabberStamp, TellTable and Wayang Authoring. The analysis of EDSE with this model allows us to identify, at first glance, the strengths and weaknesses of the EDSE at hand and make appropriate comparisons. Specifically, the most collaborative EDSE that also give the users the highest control are ToonTastic and TellTable. What is more, Toontastic is the EDSE with the highest coherence, continuity and structure. The EDSE that needs the greatest cognitive effort for a user to get acquainted with it and the impact of space plays the most important role is Kodu, which is also the most interactive EDSE. In Storytelling Alice the users get most drawn into the EDSE story. Moreover, the EDSE in which the user has the highest contribution to the story material is JabberStamp, while Kodu and Wayang Authoring have the most concrete material. Finally, all the EDSE except for JabberStamp and TellTable take place in a thoroughly virtual world. An imminent goal of this research effort is to reflect on the analysis of existent EDSE for the development of general pedagogical guidelines for the development of EDSE and finally to use these guidelines in combination with the "Dimension Star" model for the construction of a novel EDSE.

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Περίληψη: Η ψηφιακή αφήγηση έχει βαθιές ρίζες στην ανθρώπινη κουλτούρα. Ωστόσο, η σύγχρονή της μορφή, η ψηφιακή αφήγηση είναι ένα πολύ πρόσφατο πείραμα. Για την αξιολόγηση εκπαιδευτικών λογισμικών ψηφιακής αφήγησης (ΕΛΨΑ) έχουν αναπτυχθεί ορισμένα μοντέλα, βοηθώντας σημαντικά στην ανάλυση και κατηγοριοποίησή τους. Ένα χρήσιμο, περιεκτικό και αντιπροσωπευτικό μοντέλο αξιολόγησης ΕΛΨΑ είναι το "Αστέρι Διαστάσεων" το οποίο προτείνει την αξιολόγηση των ΕΛΨΑ με βάση 12 διαστάσεις-κριτήρια. Στην παρούσα εργασία, με την βοήθεια του προαναφερθέντος μοντέλου, θα αξιολογήσουμε και θα κατηγοριοποιήσουμε τα ΕΛΨΑ της τελευταίας πενταετίας. Αυτή η μελέτη μπορεί να βοηθήσει τους ερευνητές ΕΛΨΑ να έχουν μια σαφή εικόνα για την κατάσταση αυτού του επιστημονικού πεδίου καθώς επίσης και τους καθηγητές να επιλέγουν τα κατάλληλα ΕΛΨΑ, έτσι ώστε να υποστηρίξουν την εκπλήρωση συγκεκριμένων μαθησιακών στόχων στις τάξεις τους.

Λέξεις κλειδιά: ψηφιακή αφήγηση, αξιολόγηση, μοντέλο "Αστέρι Διαστάσεων", λογισμικά ψηφιακής αφήγησης, ανάλυση-κατηγοριοποίηση