A Novel Pedagogical Evaluation Model for Educational Digital Storytelling Environments

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Abstract: Digital storytelling is a modern expression of the ancient art of storytelling and represents a challenging new tool in the service of education. This paper introduces a novel model for the evaluation of the pedagogical soundness of Educational Digital Storytelling Environments (EDSE). This model is based on modern social and constructivist views of learning and is consisted of sixteen dimensions. The model is in the form of a star, named 'Digital Storytelling pedagogical evaluation star' consisting of sixteen peaks as the number of the dimensions of the aforementioned evaluation model. The proposed model may help the researchers and the designers to pedagogically analyze existent EDSE and to make appropriate decisions for the design of future EDSE. Moreover, this model can help teachers to choose appropriate EDSE so that be able to fulfill specific pedagogical goals in their classrooms. Finally, a representative EDSE is analyzed using the aforementioned evaluation model.

Introduction

The power of stories and myths is so great and ubiquitous in all societies and all times that they continue to shape our psyche and behavior (Chinen, 1989). Education through storytelling has been used throughout history for teaching and learning (Abrahamson, 1998). Stories can help make meaning out of experience (Bruner, 1996). In conceiving and constructing their stories, students become more cognizant of the contexts and backgrounds that shape their perspectives. This helps to demystify theory and empower students to become theorizers of their own historical and cultural experiences (Benmayor, 2008). Moreover, narrative is an important epistemic modality (Papadimitriou, 2003). Epistemic modality refers to the way a speaker writer communicates his doubts, certainties and predictions.

Due to storytelling's central role in living and learning and the technological explosion during the past few decades, it is not surprising that Digital Storytelling (DS) enters the academic mainstream (Ohler, 2005/2006). Despite the lack of research, educators appear to be having great success using DS for educational purposes. As DS grows in popularity, it continues to change and take on a local flavor (Salpeter, 2005). Nevertheless, DS in education is still in its infancy and much remains to be done so that the DS become 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.

To this end, a number of requirements (technical & pedagogical) which may serve as criteria for digital story and related areas of digital learning software evaluation have been reported: Schafer (2004) has proposed an evaluation model of DS applications consisting of the following twelve dimensions: Concreteness, involvement, coherence, continuity, structure, cognitive effort, virtuality, spatiality, control, interactivity, collaboration and immersion. Nokeleinen (2006) proposes a model consisting of a number of pedagogical criteria for empirical assessment of digital learning material, namely: Learner control, learner activity,

cooperative/collaborative learning, goal orientation, applicability, added value, motivation, valuation of previous knowledge, flexibility and feedback. Spierling (2002) 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. Furthermore, 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. Finally, Murray (1998) introduces three categories for the analysis of digital story applications: immersion, agency and transformation. The limited number of existing DS evaluation models shows that pedagogical aspects emerged from modern social and constructivist views of learning (Piaget, 1952, Bruner, 1960, Vygotsky, 1978, Jonassen, 1999) for designing/ evaluating EDSE are not fully addressed and these are also much less frequently studied than technical ones. The contribution of this paper is, the formation of a model consisting of appropriate pedagogical criteria-dimensions, based on the aforementioned views of learning, that could be used for pedagogically analyzing and evaluating EDSE.

In the next section of this paper, the aforementioned basic and essential dimensions that can pedagogically characterize an EDSE will be outlined and the role of each dimension in the design and the development of an EDSE will be discussed. Thus, a pedagogical evaluation model of EDSE will be constructed in the form of a star (named 'DS pedagogical evaluation star'). The length of each peak of the star will be proportional to the features of each digital story. Then, Toontastic, a representative of EDSE, will be analytically evaluated by using the proposed 'star'. Finally, the paper ends with the discussion of essential points of the proposed model and a summary as well as our future research plans.

The Pedagogical Evaluation Model

The purpose of this paper is to describe appropriate pedagogical dimensions of EDSE which will be used as criteria for pedagogically analyzing and evaluating EDSE.

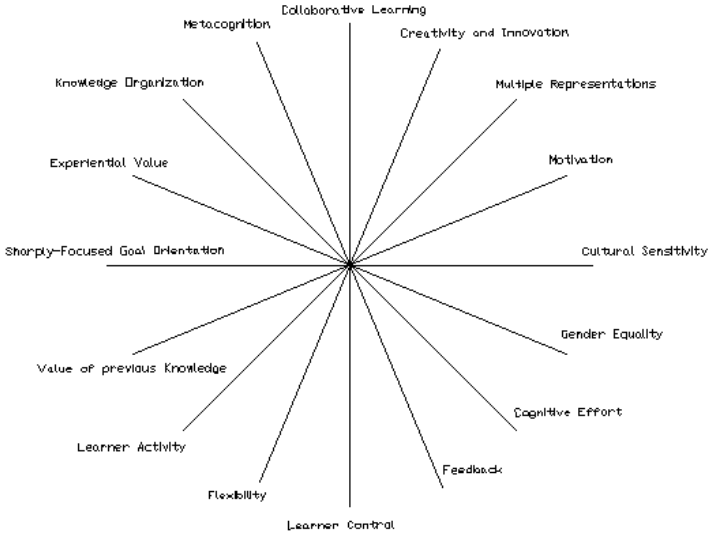

Figure 1: DS Pedagogical Evaluation Star

In fact, this study will focus exclusively on some basic pedagogical factors that are essential to be supported by an EDSE. The selection of the aforementioned pedagogical factors was based on basic aspects of modern social and constructivist learning approaches (Piaget, 1952, Bruner, 1960, Vygotsky, 1978, Jonassen,

1999). The typical 4-grade Likert scale for measuring each dimension will be used (low, medium, high, very high). In fact, sixteen dimensions are proposed for the evaluation of the pedagogical soundness of EDSE, namely: collaborative learning, creativity and innovation, multiple representations, motivation, cultural sensitivity, gender equality, cognitive effort, feedback, learner control, flexibility, learner activity, valuation of previous knowledge, sharply-focused goal orientation, experiential value, knowledge organization and metacognition (fig. 1). Next, we proceed to briefly describe each dimension and provide some explanations about its possible use in the context of DS.

A. *Collaborative Learning*: Collaborative learning refers to instructional methods in which learners work together in pairs or small groups to accomplish shared goals (Slavin, 1992). Collaborative learning goes to the roots of long-held assumptions about teaching and learning. Classroom roles change: both teachers and students take on more complex roles and responsibilities (MacGregor, 1990). DS is an educational tool that can encourage collaborative learning since many children can be involved in the creation of a digital story. There are some EDSE that promote collaborative learning such as Toontastic (Russel, 2010) and Scratch (http://scratch.mit.edu/).

B. *Creativity and Innovation*: There is a plethora of definitions about creativity and innovation. As Wehner, Csikszentmihalyi and Magyari-Beck (1991) pointed out: the mass of research on creativity can be compared to the elephant in the fable in which blind men have to touch it in order to describe it. As everyone is touching a different part, they all come to a different conclusion as to what it is, and fail to recognize it as an elephant. In brief, creativity and innovation refers to the phenomenon whereby a person creates something new (a product, a solution, a work of art etc.) that has some kind of value. DS can be the ideal channel to promote creativity and innovation. Students can be given tools to create digital stories from scratch, thus freeing their imagination (e.g. Storytelling Alice; Kelleher, 2006).

C. *Multiple Representations*: A common justification for using more than one external representation in teaching and learning is that it is more likely to capture a learner's interest and, in so doing, play an important role in promoting conditions for effective learning. A number of studies have shown that a lot of advantages can accrue from their use (Ainsworth, 1998, Cox, 1995). Multiple representations contain complementary information or support complementary cognitive processes and one representation can be used to constrain possible (mis) interpretations from the use of another. Multiple and linked representations also provide the learners with opportunities to observe how variations on the one system affect the other systems. In this way learners can acquire a more deep and cohesive view about the learning concepts in question (Kaput, 1994, Kordaki, 2005, Kordaki, Miatidis and Kapsampelis, 2008). The use of multiple representation systems can also encourage learners to develop multiple perspectives of the concepts in question at the same time enhancing their knowledge about these concepts (Kordaki, 2009). As far as DS is concerned, a lot of external representations can be used such as text, voice, pictures, graphs, diagrams, tables, videos etc. so as to reinforce the messages designed to be conceived by the learners.

D. *Motivation*: Motivation is a key factor for achieving educational goals (Deci, Vallerand, Pelletier and Ryan, 1991). There are two main types of motivation: intrinsic and extrinsic. Intrinsic motivation is defined as the doing of an activity for its inherent satisfactions, while extrinsic motivation refers to doing an activity for to attain some separable outcome (Ryan & Deci, 2000). DS gives another dimension to learning, making students striving for learning because the material is interesting in itself. What is more, some EDSE may provide external rewards (e.g. grades, publishing the best digital story in the school's blog (e.g. VoiceThread; http://voicethread.com/) that can extrinsically motivate students.

E. *Cultural Sensitivity*: Cultural sensitivity is a very important pedagogical factor (Elwyn, 1998) that should be taken into consideration in the design of an EDSE. Powel (1993) argues that few instructional design courses include cultural diversity in their design. A few EDSE allow an occasional minority role for an actor or perhaps include culturally direct albeit safe references in terms of music, location or other cultural aspects. Although EDSE may not be able to adapt to every cultural norm, they should be designed to be as culturally sensitive as possible, accommodating diverse ethnic and cultural backgrounds among learners.

F. *Gender Equality*: International consensus on education priorities is very important to achieve gender justice

in the educational sphere (Subrahmanian, 2005). Of course gender inequality in education is not just a matter of DS software or even all computer-based educational software, but can be found in all aspects of education. EDSE should be designed in a way that promotes gender equality. This can be done, for example, by providing appropriate tools (e.g. animated character libraries) for the students to construct stories with both male and female heroes in contradiction to the animated characters in existing EDSE which are mainly male.

G. *Cognitive Effort*: The cognitive effort required for the students to get acquainted with and use a computer based tutoring system is a key factor for its pedagogical success (Arroyo, Meheranian, Woolf, 2010). The environment should be as simple and understandable as possible, so that students with the help of a printed or digital guide to absorb the capabilities of the software in order to fulfill the appropriate educational objectives. There are some EDSE that need low cognitive effort such as Facade, (Mateas, 2003) while other have high cognitive load for the students, like Toontastic (Russel, 2010).

H. *Feedback*: The necessity of feedback in a computer system is emphasized by psychologists, pedagogists, and usability engineers (Norman, 1998). The main role of feedback is to inform and to motivate the user to increase his or her effort and attention. In education there are two types of feedback intrinsic and extrinsic. Intrinsic feedback can enforce learners to develop core cognitive skills such as hypothesis formation and testing. Regarding extrinsic feedback, there are also two types and both considered beneficial – negative feedback prompts improvements, while positive feedback increases motivation. In EDSE there can be intrinsic feedback from the environment during the exploration of a digital story while extrinsic feedback can be provided during its building, warning students when they are not following the instruction given or when they have forgotten a part of the construction of the digital story. In EDSE feedback can be provided during the story construction, warning students when they are not following the instruction given or when they have forgotten a part of the construction of the digital story (e.g. music, climax or faulty programming in environments like Storytelling Alice (Kelleher, 2006).

I. *Learner Control*: The four fundamental categories of learner control in an educational environment are: pace control, sequence control, content control and advisory control (Milheim & Martin, 1991, Clark & Mayer, 2002, Kraiger & Jerden, 2007). Learner control in EDSE refers to all the aforementioned learner control options that allow learners to make decisions about the time spent in each story that is constructed, the order in which they construct the story material, the content of each story and the access to learning support such as helps, examples or pedagogical intelligent agents.

J. *Flexibility*: Flexible learning takes into account learners individual preferences and background. The more adaptable an environment is, the easier it is to fit the student's individual needs (Leflore, 2000). Of course the personalization of an EDSE depends on its objectives. For example, the EDSE Storytelling Alice which teaches programming through DS can monitor the programming mistakes of students, and give them appropriate advice to correct their errors. The software should look over the shoulders of the interface users to help them. Digital storytelling environments using artificial intelligence techniques is a very good way to achieve flexibility.

K. *Learner Activity*: The learners' independent activity can be increased when the teacher changes his role from a traditional didactic one to that of a facilitator (Reeves, 1994). The constructivist view in education which is supported by the views of Piaget, John Dewey and Lev Vygotsky holds that teachers should be facilitators who help students construct their own understandings and capabilities in carrying out challenging tasks. Ohler (2008) offers further detail about the teacher's role in the technical aspect of DS. He states, that the teacher should help students to manage their skills and talents by helping them to "tell a story that is strengthened rather than weakened by the media they use, form a learning community so they can share their ideas and talents, meet the educational goals of the project, and leverage their imagination and creativity". The emphasis is on the activity of the student rather than on that of the teacher. There is an increasing number of EDSE (e.g. Toontastic, Storytelling Alice) that enhance learners' activity, letting them construct their own stories, while teachers stay in the background, having a facilitative role.

L. *Value of Previous Knowledge*: Krause, Bochner and Duchesne (2009) comment that "as learners interact with their environment, they link information learned through experience to previous knowledge, and so construct new understandings and knowledge". Constructivism encourages teachers to recognize the value of prior

knowledge and experiences that each child brings with them into the classroom, and help them build on their understandings of the world by providing appropriate learning experience plans. The importance of previous material and the cumulative nature of knowledge have to become clear to the learner (Nokelainen, 2006). EDSE that are designed to teach specific concepts should provide learners with opportunities to review the central concepts of previous studies that are crucial for understanding the present concepts. Thus, learners will be able to construct their new knowledge based on their prior knowledge.

M. *Sharply-Focused Goal Orientation*: Goals range from sharply-focused ones (e.g. learn how to drive a car) to unfocused ones (e.g. learn to appreciate classical music). According to constructivist learning theory, the goals should be clearly defined, but they have to originate, as much as possible, with the learners themselves (Wilson & Myers, 2000). Goal orientation was also further divided into two distinct constructs: proving and avoidance (VandeWalle, 2001). Proving goal orientation focuses on demonstrating one's competence, and gaining favorable judgments from others. Avoiding goal orientation focuses on ways of avoiding negation of one's competence as well as unfavorable judgments by others. The design of EDSE is desirable to promote both proving and avoidance goal orientation.

N. *Experiential Value*: Experiential learning is considered as a change in an individual that results from reflection on direct experiences (Itin, 1999). The problem for teachers and students is how to make meaning out of their experience. In experiential education, the student becomes more actively involved in the learning process than in traditional, 'didactic' education. DS is an intuitively experiential learning process; however the extent of experiential validity of an EDSE depends a lot on the degree of immersion provided by the software.

O. *Knowledge Organization*: Knowledge organization is a domain concerned with the structuring of what is known (Smiraglia, 2005). Knowledge organization in the field of computer based education can be used to effectively facilitate learning, usually in the form of concept maps. Concept map is a graphical tool for organizing and representing knowledge. It can help teachers to assess children's conceptual development and understanding, identify misconceptions, and facilitate learning by building new knowledge on old knowledge (Birbilli, 2006). Concept maps and story grammars can be an effective approach for developing learner-centered storytelling tools which can help students develop and apply the knowledge about storytelling (Chen-Chung Liu, 2011).

P. *Metacognition*: Metacognition is defined as knowing about knowing (Metcalfe, & Shimamura, 1994). Artino (2009) mentioned that offering metacognitive support in a computer-based environment can increase students' learning effectiveness. Moreover, according to Azervedo (2005), scaffolding students' self-regulated learning and metacognition during learning in a computer-based learning environment can motivate students to learn from challenging tasks. Kirsh (2005) argues that a good visual design in the e-learning environment can reduce the cognitive load on students and make their learning of metacognitive skills more effective. EDSE should enhance learners' metacognitive skills. Creating superior digital stories lies more in meta-cognition than in manipulation. Most EDSE come equipped with a plethora of transitions, visual and audio effects, background music, and text styles. The focus should be on a strong narrative and a true understanding of how and why to use movement, transitions, and sounds. Of course, the "what" and "how" are important, but what really separates the advanced from the basic is the knowing "why".

Evaluation of Toontastic with the "DS Pedagogical Evaluation Star" model

Toontastic (Russell, 2010) (fig.2), 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.

Figure 2: EDSE Toontastic

The analysis of digital storytelling software Toontastic with the "DS Pedagogical Evaluation Star" model is described as follows (fig.3):

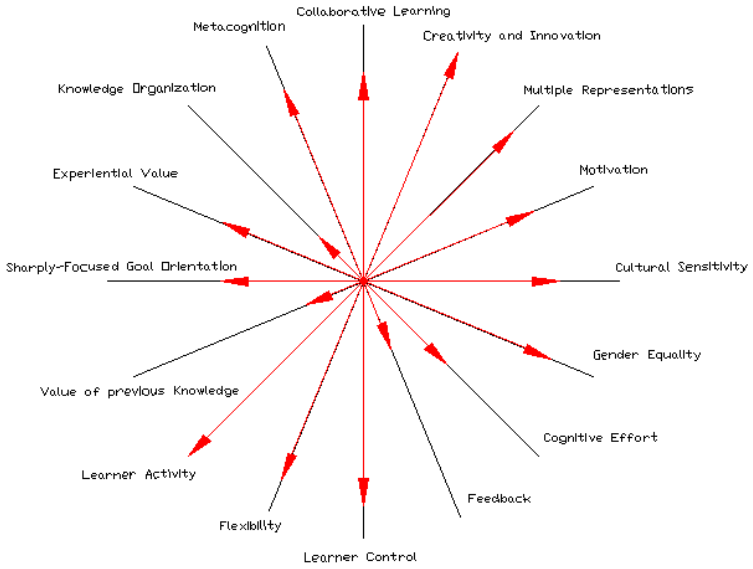

Figure 3: "DS Pedagogical Evaluation Star" for software Toontastic

As far as the dimension *Collaborative Learning* is concerned, Toontastic receives a high value since five children can paint story heroes at the same time with the five digital pens that are available. The dimension *Creativity and Innovation* receives a very high value, because students can create their own unique stories from scratch and draw their own heroes, apart from those provided by the software library. As far as the dimension *Multiple Representations* is concerned, Toontastic receives a high value, since the use of text, voice, pictures, graphs and videos are part of the software. Furthermore, the dimension *Motivation* receives a high value because Toontastic motivates students in the construction of the story with questions in each step. As far as the dimension *Cultural Sensitivity* is concerned, the software receives a high value, because the digital library of the software has characters from diverse cultural backgrounds. What is more, through sharing the stories with other children around the world, children should gain greater cultural perspective. Additionally, the dimension *Gender Equality* receives a high value, because there is diversity in the gender of the animations and the student or the teacher can draw their own characters. The dimension *Cognitive Effort* receives a medium value, because considerable effort is needed by the user to understand the functionality of the software. As far as the dimension *Feedback* is concerned, Toontastic receives a low value, since there is no feedback to the students in the development of their stories, except for watching the video of the digital story they have created. The dimension *Learner Control* receives a very high value, because the user can build step by step, every piece of the story. Futhermore, the dimension *Flexibility* receives a high value, because each student can create the characters and the story he wants, thus personalizing the story creation. As far as the dimension *Learner Activity* is concerned,

Toontastic receives a very high value, because it gives great emphasis in the student's activity empowering them to create and share their own stories with other children around the world, thus helping them learn from its other lives, following Vygotsky theory (1978) that children often learn more from social dialogues at a peer level, than from formal adult instruction. The dimension *Value of previous Knowledge* receives a low value, because there is not any utility in the software which helps students to review their previous knowledge. In addition, the dimension *Sharply-Focused Goal Orientation* receives a medium value, because the majority of the software's goals are abstract (e.g. encouraging outward creative expression, story creation, freeing the imagination). Moreover, the dimension *Experiential Value* receives a medium value because the software has templates and heroes who remind real life characters and situations, however it doesn't create conditions of virtual reality. As far as the dimension Knowledge Organization is concerned, Toontastic receives a low value, since there is not any special utility for the organization of students' knowledge like concept maps. Finally, the dimension Metacognition receives a high value, because Toontastic helps children debug and rebuild their mental models through a four step process via which children adapt their mental models (fig. 4).

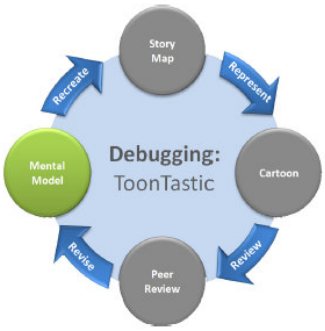

Figure 4: Toontastic debugging process

Summary and future research plans

A pedagogical model for the evaluation of educational digital storytelling environments (EDSE), called "DS Pedagogical Evaluation Star" was introduced in this paper. In fact, sixteen pedagogical dimensions were proposed, which will help in a pedagogical analysis and pedagogical evaluation of EDSE, namely: collaborative learning, creativity and innovation, multiple representations, motivation, cultural sensitivity, gender equality, cognitive effort, feedback, learner control, flexibility, learner activity, valuation of previous knowledge, sharply-focused goal orientation, experiential value, knowledge organization and metacognition. A representative EDSE the 'Toontastic" software was also analyzed/evaluated by using the aforementioned pedagogical evaluation model. The diagrammatic pedagogical analysis of digital storytelling environments (DSE) using the "DS Pedagogical Evaluation Star" model allows the users (teachers and researchers) to identify, at first glance, the pedagogical strengths and weaknesses of the EDSE at hand and make comparisons based on the dimensions of the edges of the star. Moreover, the "DS Pedagogical Evaluation Star" can become a useful tool for software developers of digital stories especially in the early stages of conception and design of EDSE. More specifically, by categorizing pedagogically DSE using the dimensions described by the "DS Pedagogical Evaluation Star", digital storytelling software designers have the opportunity to benchmark, compare and finally choose from successful examples. In addition, teachers can use the results of the analysis with the "DS Pedagogical Evaluation Star" so as to choose appropriate EDSE which are in line with the pedagogical goals they want to achieve in their classrooms. A future goal of this research effort is the analysis of existent EDSE using the proposed "DS Pedagogical Evaluation Star" and subsequently the development of general pedagogical guidelines for the development of applications in digital storytelling environments. Finally, the construction of an EDSE taking into consideration the results of this analysis in combination with the sixteen dimensions of this evaluation "Star" is in our future research plans.

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