Digital Storytelling Teaching Robotic Basics in a Surgical Robotic Curriculum

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Abstract. Digital Storytelling (DST) is a powerful tool to teach complex concepts. DSTs are typically used in humanistic sciences, but several researches showed that are a wonderful tool also for scientific sciences because they are more involving, contextualized and it is easier that lead to deep reflections. The classical use of DSTs plans that the story is the content, while the digital medium is the way to tell it. Our approach is slightly different, the story is not the content but a glue for the main contents, while the digital medium remains the way to explain the lesson. We propose to use DST to teach to surgeons the robotics basics, using a story that should be involving for our target population (a surgical operation) to teach specific concepts about robotics in surgery.

Keywords: Digital Storytelling, Robotics, Training

1 Introduction

Research indicates that learning must be designed from a constructivist approach that encourages students to learn in a social context, developing ability to readily create new knowledge, solve new problems and employ creativity and critical thinking [1–3]. Spivey [4] indicated that constructivists view students as constructive agents and view knowledge as built instead of being passively received by students, whose ways of knowing and understanding influence what is known and understood.

Usually theoretical informations are taught through academic lectures, that can be high demanding to trainees in cognitive and attentional terms. If the trainee needs to learn concepts from a field that is distant and very different from her/his typical knowledge field, cognitive and attentional resources required are definitely superior compared to the resources required to learn an equally complex concept, but in her/his typical topics.

Classically Digital Storytelling (DST) can be defined as: "a modern expression of the ancient art of storytelling. Throughout history, storytelling has been used to share knowledge, wisdom, and values. Stories have taken many different forms. Stories have been adapted to each successive medium that has emerged, from the circle of the campfire to the silver screen, and now the computer screen" [5].

The particular nature of DST involves several sensory channels and a multitude of cognitive processes that harness the conventional linguistic way to other, less common, but that allow a more comprehensive understanding, like spatial, musical, interpersonal, intrapersonal, naturalist and bodily-kinaesthetic ways [5].

Barrett [6] found that DST facilitates the convergence of four learning strategies centered on students:

1. student engagement,
2. reflection for deep learning
3. project based learning
4. effective integration of technology into instruction

The DST movement was founded by Joe Lambert and the late Dana Atchley. From this movement in the late 1980s born the Center for Digital Storytelling in Berkely, California [7]. This organization, since the early 1990s, provided training and assistance to people interested in creating and sharing their personal narratives.

This organization provided the Seven Elements of Digital Storytelling, a fundamental starting point to begin working with DST:

1. Point of View - What is the main point of the story and what is the perspective of the author?
2. A dramatic question - A key question that keeps the viewer's attention and will be answered by the end of the story.
3. Emotional content - Serious issues that come alive in a personal and powerful way and connects the story to the audience.
4. The gift of your voice - A way to personalize the story to help the audience understand the context.
5. The power of the soundtrack - Music or other sounds that support and emellish the storyline.
6. Economy - Using just enough content to tell the story without overloading the viewer.
7. Pacing - The rhythm of the story and how slowly or quickly it progresses.

The main typologies of DST concern personal events, hystorical events, or to teach about specific scientific fields [8], but DST is not limited to these fields.

DSTs are story told through a technological medium, but it's considered very important that the story is in the foreground, while the technological medium is in the background [9] Ohler [10] underlights the importance to build a storyboard, or a storymap to develop an effective DST. According to Ohler, the essential components of DST are:

1. A call for adventure – the need to solve a specific situation.
2. Problem solution involving transformation – the situation to be solved requires a transformation, which can happen in a number of ways, including skill acquisition, maturation, learning and self-discovery.

3. Closure – The story comes to a meaningful conclusion, involving the main character's realization of something significant.

Ohler clearly thought about biographic DSTs, but these three principles can be used to teach any kind of concept.

In this part of this work there is a short introduction about DST and its principles, in the following paragraph there will be a short review about how these principles were applied, and DST's main field of application.

1.1 The Several Fields of DST Application

DST technique was applied to several fields of knowledge. Its use in social studies is well known, because it develops students' understanding of democratic ideals, cultural diversity and participatory citizenship, improves their communication skills, motivates them to learn about the past and present, and creates a class bond through shared experiences [9].

An interesting application of this idea was the study by Cianciolo et al [11] that used DSTs to stimulate discussion among army's professionals to stress and to explore the effects and the possible solutions of a negative attitude towards the local population in a peace-keeping scenario in a foreign country, in this case Iraq.

DST is often considered exclusively applicable to arts and humanities, but research indicates that it's a wonderful instrument to teach mathematics and science.

Schiro in his book [12] explained how he used digital storytelling to teach students algorithms and problem solving through several stages of learning. He argued that digital stories, with other materials like worksheets, not only present mathematical skills that students need to learn but also situate the mathematics in a context that is interesting, engaging and relevant.

Papadimitriou [13] suggested that digital storytelling can be used to teach computer science and programming to a wider and more diverse audience, indeed DST was also used to teach software engineering in university courses [14].

In the medical field DST was mainly used to teach values and attitudes, for professional development, and enhancement of interpersonal communication [15–19], but there were experiences where DSTs were applied to the learning of medical knowledge [20], [21]. D'Alessandro et al [21] proposed a DST for third year medical students, developed following these educational objectives:

1. Tell individual, memorable stories from real patients in their own words.
2. Emphasize the clinical problem faced by the patient and family and de-emphasize the disease the patient has.
3. Promote primary care principles (e.g. safety and health screening)
4. Written primarily at the level of the introductory pediatric clerkship for third year medical students.
5. Used for independent study by medical students locally and nationally (i.e. not as part of a specific course).
6. Take a limited amount of time for students to work through (approximately 20–30 minutes).

7. Take a limited amount of time to author.

The DSTs' template prepared following the above principles was structured in the following manner:

8. The patient's story, evaluation process and clinical course told through the patient's voice and a clinical narrator.

9. A problem-based approach to the evaluation of the patient's problem, including differential diagnoses, history, physical examination, and laboratory and imaging evaluation.

10. A discussion of the patient's disease process based upon journal articles.

11. A brief conclusion and follow-up told through the patient's voice.

In this brief paragraph we have proposed a short review of the main fields of DST's application, focusing on medical and scientific applications. Starting from these works, we make a proposal based on some additional theoretical issues in the next section.

2 Our Proposal

DST can also be defined as the use of the technological/digital medium to tell stories to share knowledge, values, principles.

Our approach is slightly different, while in the classical approach the story is the content to learn, in our approach the story is a structure to pass contents. We found this approach in the consideration that stories are an excellent manner to pass knowledge even if the concepts are not directly connected with the theme of the story, for at least three reasons:

1. *Stories contain information chronologically organized*, harnessing the natural structure of our mind that favors episodic data, namely information about real-life experiences coming from external sources [22].

2. *Stories are a glue for informations,* they can connect a concept with a particular point of the history, like the famous mnemotechnique of loci, easing the memorization [23].

3. *Stories ease the formation of mental imageries*, learners who were instructed to create mental images of events in sentences learned two to three times as much as learners who read aloud the sentences repeatedly [24].

According to Barrett [6] conceptualization, classical DST can be graphically represented as in Fig. 1, while our proposal can be represented as in Fig. 2.

For example, if we want to teach to a child the six-times table, we can propose a DST about six small frogs. In this story each frog eats two flies for a total of twelve flies, after that they jump three times for a total of eighteen jumps, and so on. In this way the young student is engaged by the fable, the important data are episodically organized, each number is connected with a particular aspect of the story (frogs, flies, jumps, …), and it's easy to form mental imageries about each part of story.

Therefore, the original conceptualization of Bull et al [9] where in DST the story is in the foreground while the technological medium is in the background, it's reformulated so in our approach both story and the technological setup are just a

channel to teach specific concepts. In this manner clearly it isn't possible to try to teach the concepts in an implicit way, we have to highlight them, so it will be clear to trainees which concepts are important to be learned. The highlighting of a concept is an important phase, because it's necessary to extract the concept from the narrative stream, interrupting for a while the narration, the soundtrack and maybe also use a different graphical style, in order to give to trainees the needed time to recognize and memorize the concept, before to back to the narration.
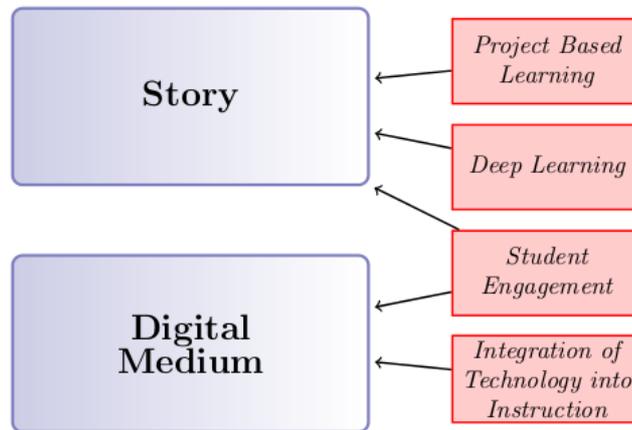
Fig 1. Classical DST according with Barret conceptualization
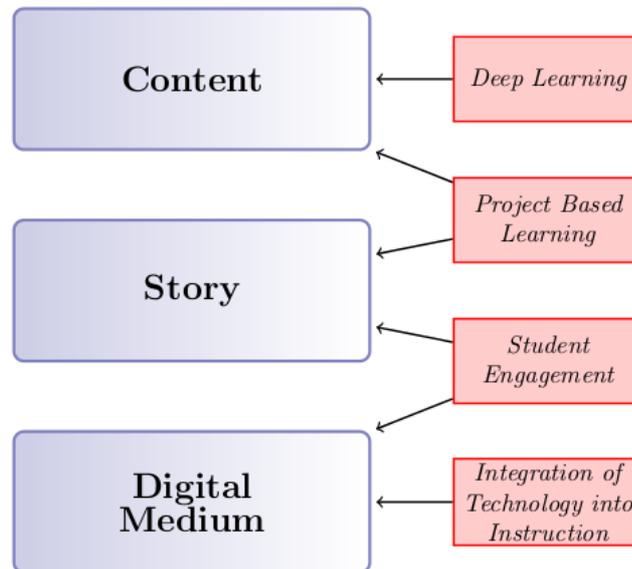
Fig 2. Our proposal according with Barret conceptualization

Following our proposal we will design DSTs for surgeons using an involving story as a glue for the important concepts. Considering the students taken as target, the

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story will be an hypothetical surgical operation, with well-defined characters thought to ease the possibility to empathize.

Each important content will be linked with an important phase of the story, in order to have concepts episodically organized, and highlighted with a pause of the narrative flow.

The main concepts to insert in the DST are summarized in the following table:

Table 1. Concepts to teach through DST.

Area		Concept
General Robotics	1.	What is a robot
	2.	...
Surgical Robotics	1.	Differences among open, laparoscopic and robot-assisted surgery
	2.	Advantages/Disadvantages of robotic surgery
	3.	The typical surgical theatre for robot-assisted interventions
Specific of the robot	1.	The console
	2.	How control the robot
	3.	Emergence button (if any)
	4.	Indexing (if any)
	5.	Movement scaling (if any)
	6.	Zoom (if any)
	7.	…
	8.	Emergency functions (if any)
Troubleshooting	1.	...

3   Conclusions

DSTs are useful tools to ease the students' learning process because they are involving, enhance deep reflections, DSTs could be connected in an overall project, and DSTs allow a real integration of technology in the learning process.

In this paper are presented the main issues needed to prepare an effective DST to introduce surgeons to the basics of robotics. Surgeons may not be familiar with robotics, and neither with other high-tech concepts. For this reason, an academic lecture about robotics could be very demanding and discouraging for surgeons.

In order to lower the cognitive resources necessary to attend to the lecture, and to capture surgeons' attention, DSTs present optimal characteristics. In the first part of this work we discuss that traditionally DSTs are considered limited to humanistic sciences, but there are successful experimentations in teaching software engineering at university courses and pediatrics to medical students.

The typical conceptualization of DSTs highlights the story, therefore DSTs are mainly used to teach a story. The approach here presented is slightly different, the story is not the content to learn, but a glue for several content. In this way it's easy to put together concepts from a field (in this case, from robotics) in a story concerning a

different field (in this case, surgery). This approach contains many advantages: there is the possibility to link unknown concepts with known concepts, and these connections could be chronologically organized, characteristics that are typical of the most famous mnemotechnique, the loci method. Moreover this approach eases the formation of mental imageries, another feature that is shared with the most of mnemotechniques.

DSTs are teaching tools that answer to several pedagogical principles, useful to teach concepts of each level of complexity. Our approach to DSTs is not limited to teaching robotics, it's a proposal that could be applied to many knowledge fields notwithstanding their complexity, especially useful with students whose age is ranged from 12 yo to the adulthood.

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