Education Tech Research Dev (2008) 56:487–506
DOI 10.1007/s11423-008-9091-8

INTERNATIONAL REVIEW

Digital storytelling: a meaningful technology-integrated approach for engaged student learning

Alaa Sadik

Published online: 11 April 2008

Abstract Although research emphasizes the importance of integrating technology into the curriculum, the use of technology can only be effective if teachers themselves possess the expertise to use technology in a meaningful way in the classroom. The aim of this study was to assist Egyptian teachers in developing teaching and learning through the application of a particular digital technology. Students were encouraged to work through the process of producing their own digital stories using MS Photo Story, while being introduced to desktop production and editing tools. They also presented, published and shared their own stories with other students in the class. Quantitative and qualitative instruments, including digital story evaluation rubric, integration of technology observation instruments and interviews for evaluating the effectiveness of digital storytelling into learning were implemented to examine the extent to which students were engaged in authentic learning tasks using digital storytelling. The findings from the analysis of students-produced stories revealed that overall, students did well in their projects and their stories met many of the pedagogical and technical attributes of digital stories. The findings from classroom observations and interviews revealed that despite problems observed and reported by teachers, they believed that the digital storytelling projects could increase students' understanding of curricular content and they were willing to transform their pedagogy and curriculum to include digital storytelling.

Keywords Digital storytelling · Engaged learning · Photo story · Technology integration

Introduction

Within the last 10 years, the Egyptian Ministry of Education (MoE) with the assistance of many international organizations (such as USAID and UNESCO) has introduced many education reforms to improve the educational system and raise teachers' technological

A. Sadik (✉)
Department of Instructional & Learning Technologies, College of Education,
Sultan Qaboos University, Muscat, Sultanate of Oman
e-mail: alaasadik@squ.edu.om; alaasadik@hotmail.com

awareness and encourage them to integrate Information and Communication Technology (ICT) into the curriculum with a greater emphasis on science, mathematics and the use of computers. In addition, new learning resource centers are being set up in schools, complete with laboratory equipment, audio-visual systems, computers and other teaching aids.

However, although Egypt has made great strides in its general educational arena, growth in technological supports that facilitate educational advances have been slower. The use of computer software and hardware has not been fully understood or used and the integration of technology into the Egyptian education system is needed.

Jacobsen (2001) believe that many teachers worldwide are not able to adopt technology for teaching and learning tasks, and the gap between technology presence in schools and its effective use is too wide. Many teachers believe that technology integration is a difficult, time-consuming and resource-intensive endeavor and is more trouble than it is worth (Sheingold and Hadley 1990). The under-utilization of technology is probably a result of a lack of vision of technology's potential for improving teaching and learning (Office of Technology Assessment 1995) and the difficulty to cross the bridge between technology's capabilities and curriculum requirements (SERVE 1996).

Dexter et al. (1999) indicate that the effectiveness of technology integration into education is largely dependent upon its ability to engage students into learning. Trilling and Hood (1999) believe that the key in using educational technology is to utilize meaningful activities that may engage students to construct their knowledge in different ways, not available before the technology was introduced. Studies have shown that learner engagement is paramount to learning success (Herrington et al. 2003).

Lim et al. (2006) reviewed the literature and found that there is a myriad of definitions for the term 'engagement'. They concluded that 'what is apparent about the definitions of engagement is that they entail some kind of mindfulness, intrinsic motivation, cognitive effort, and attention' (p. 213). However, there are different levels of engagement that one can attain: The engagement can either be classified as high or low.

Meaningful technology integration and learning

Meaningful technology integration is defined as curricula utilizing authentic tasks that intentionally and actively help learners to construct their own meanings from thinking about experiences and allows for more interdisciplinary project-based instruction (Jonassen et al. 1999). Integration is defined not by the amount or type of technology used, but by how and why it is used (Earle 2002).

Meaningful integration of technology is achieved when students are able to select technology tools to help them obtain information in a timely manner, analyze and synthesize the information and present it professionally (Harris 2005). However, harnessing the power of the integration of technology requires not only a new or advanced technology, but also a systematic way of utilizing the technology to improve student learning (Schofield 1995).

Research indicates that in order to achieve meaningful technology integration, learning must be designed from a constructivist approach that encourages students to learn in a social context and help them to develop an ability to readily create new knowledge, solve new problems and employ creativity and critical thinking (Griest 1996; Hoffman 1997; Mergendollar 1997; Richards 1998). Spivey (1997) 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.

In addition, the interaction between students, the flow of ideas and thinking aloud encourage students to foster active learning, in which users discover and address gaps in their understanding when explaining concepts to others (Kafai et al. 1997; Tyner 1998).

Constructivist strategies include collaborative and cooperative learning methods, engaging in critical and reflective thinking and evaluation through electronic portfolios (Nanjappa and Grant 2003). Jonassen and Carr (2000) believe that in order to help students to construct their knowledge, they should be actively involved in learning with the help of ICT tools. In addition, Wheatley (1991) argued that because a student will construct his/her own meaning based on his/her interpretation, technology can become a vital educational tool depending on the way it is used in learning. Strommen and Lincoln (1992) believe that it is not which technology is used, but how the technology is used which is relevant to a constructivist classroom.

For example, the initial computer's role in education has been largely viewed through Computer Assisted Instruction (CAI), which is generally used for low-end tasks or providing a richer and more exciting learning environment, such as drill and practice (Office of Technology Assessment 1995; Duffy and Cunningham 1996; Roe et al. 1998). However, teachers can use computers, as tools for accessing information, interpreting and organizing their personal knowledge and producing and representing what they know to others, so as to engage students more, resulting in more meaningful and transferable knowledge (Jonassen et al. 1993).

Lim and Tay (2003) classified ICT tools used in the classroom to improve student learning into four types: (1) informative tools; (2) situating tools; (3) communicative tools; and (4) constructive tools. Informative tools are applications that store and provide vast amounts of information in various formats (e.g., databases, encyclopedias and web resources). Situating tools are systems that situate students in an environment where they may experience the context (e.g., simulations and games). Communicative tools are systems that facilitate communication between the student and others (e.g., e-mail and discussion boards).

Constructive tools are general-purpose ICT tools that can be used for manipulating information, constructing student's own knowledge or to produce a certain tangible product for a given instructional purpose. PowerPoint and Word, for example, are found to be the most frequently used constructive tools by students for their presentations and special curriculum-based projects (Lim and Tay 2003). Multimedia authoring and presenting tools, in particular, like PowerPoint, Illustrator, MultiMedia Builder, HyperStudio, MovieMaker and iMovies have proved to be good constructive tools to learn through production, collaboration and project management.

Digital storytelling and the curriculum

Storytelling is the original form of teaching (Pedersen 1995). It is a simple but powerful method to help students to make sense of the complex and unordered world of experience by crafting story lines (Bruner 1990; Gils 2005). Although storytelling is not new, the idea of digital storytelling is new (Meadows 2003).

Within the last 10 years, digital cameras, editing software, authoring tools and electronic media outlets have encouraged teachers to utilize many more approaches and tools than ever before to help students to construct their own knowledge and ideas to present and share them more effectively (Standley 2003). One of these powerful approaches to multimedia production is digital storytelling.

Meadows (2003) believes that digital storytelling is the social practice of telling stories that makes use of low-cost digital cameras, non-linear authoring tools and computers to create short multimedia stories. The Digital Storytelling Association (2002) describes Digital storytelling 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.

Robin and Pierson (2005) believe that digital storytelling has captured the imagination of both students and teachers and the act of crafting meaningful stories has elevated the experience for students and teachers. Compared to conventional storytelling, digital storytelling audiences are viewed not only as listeners but also as learners who can interact and shape the story (Dorner et al. 2002).

Lynch and Fleming (2007) indicate that:

> [The] flexible and dynamic nature of digital storytelling, which encapsulates aural, visual and sensory elements, utilises the multitude of cognitive processes that underpin learning-from verbal linguistic to spatial, musical, interpersonal, intrapersonal, naturalist and bodily-kinaesthetic (p. 7).

Barrett (2006) found that digital storytelling facilitates the convergence of four student-centered learning strategies: student engagement, reflection for deep learning, project-based learning, and the effective integration of technology into instruction.

Robin (2005) argued that educators at all levels and in most subjects can use digital storytelling in many ways to support students' learning by encouraging them to organize and express their ideas and knowledge in an individual and meaningful way.

Jonassen and Hernandez-Serrano (2002) suggested three ways to support learning using stories. First, they can be used as exemplars of concepts or principles being taught by direct instruction. Second, they can be used as problem cases to be solved by students. Third, stories can be used as advice for students, for helping them learn to solve problems.

Gils (2005) suggested many advantages of using digital storytelling in education: (1) to provide more variation than traditional methods in current practice; (2) to personalize learning experience; (3) to make explanation or the practicing of certain topics more compelling; (4) to create real life situations in an easy and cheaper way; and (5) to improve the involvement of students in the process of learning.

According to Pedersen (1995), stories are the oldest form of literature. Tsou et al. (2006) found that integrating digital storytelling into the language curriculum is a creative language learning technique that can improve student's level of learning in reading, writing, speaking and listening.

In addition, Combs and Beach (1994) indicated that including storytelling in the social studies curriculum 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.

While digital storytelling is most often associated with the arts and humanities, research indicates that it can also be an effective strategy for learning in mathematics and science. In mathematics education, Jonassen (2003) believes that story problems are the most common form of problem solving in education. "Students begin solving story problems in early elementary school and do not escape until graduate school or beyond" (p. 294). He

argued that story problems are found in simple combine problems (e.g., Tom has three apples. Mary gave Tom 3 more apples. How many apples does Tom have in the end?) and complex problems in advanced mathematics and physics.

Schiro (2004), for example, used digital storytelling to teach students algorithms and problem solving through several stages of learning in order to help them develop mathematical skills. 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 (2003) suggested that digital storytelling can be used to teach computer science and programming to a wider and more diverse audience. He indicated that digital storytelling can be used, for example, to share with students Al Khwarizmi's discovery of arithmetic algorithms notes on how to calculate the Bernoulli numbers without human head and hand to bring the beauty power and coolness of the message with more clarity and less pain.

Problem arising from the study

Although the Egyptian Ministry of Education has invested in integrating computers and technology with all areas of learning, the researcher noticed that teachers, in general, struggle to incorporate computer applications into regular classroom instructional practices to enhance learning due to the ineffective and inappropriate training and lack of vision of technology's potential for improving learning. Teachers have not been introduced before to meaningful technology-based approaches that would give some sort of challenge and purpose to the activities that often happens in authentic situations (Pritchard 2004).

In addition, no previous study has examined the potential of computer-based multimedia applications, in general, or digital storytelling, in particular, in encouraging Egyptian teachers to integrate technology into the curriculum and engage students in technology-rich, active and cooperative learning situations that help them to construct their own learning.

Research questions

The investigation aims to understand better the impact on student learning when they take advantage of digital storytelling for their learning. Therefore, this study seeks to answer the following three questions:

1. To what extent can students be engaged in authentic learning tasks with digital storytelling?
2. How effective is a digital storytelling approach in supporting teachers to effectively integrate technology into learning?
3. What are the teachers' concerns and views regarding the implementation and integration of digital storytelling into learning?

Objectives of the study

The main intention of this study, then, is to help teachers develop the nature of teaching and learning through a particular application of digital technologies that may result in a

shift in technology utilization. By providing a clear picture of what and how teachers and students use digital storytelling, much can be learned to facilitate meaningful integration of the technology into Egyptian schools. In addition, the investigation aims to give a clearer picture and a better understanding of the impact on student learning when teachers and students take advantage of digital storytelling for their teaching and learning tasks.

Significance of the study

This study may help teachers by providing them with a new philosophical and realistic perspective on the integration of technology into curriculum that may result is a shift in technology utilization. By providing a clear picture of what and how teachers integrate digital storytelling, much can be learned about how to facilitate meaningful integration of the technology into schools.

Methodology

According to Stake (1995), examining teachers' changes in skills and behaviors, as well as their perceptions of an innovation to learning, requires a methodology that allows for individual thought and expression to be recorded and analyzed. Therefore multiple methods of data collection and analysis were employed to enhance the validity and reliability of the study. A scaling rubric instrument is used to assess students' success and level of engagement in authentic learning using digital storytelling. In addition, observation and interview are used in this study to investigate factors that influenced teachers as they implemented and integrated digital storytelling in their curricula and provide a concrete and contextual knowledge of their concerns and perceptions of the integration process.

Participants, settings and procedures

Since the purpose of this study is to understand better and describe the impact on student learning when teachers and students take advantage of digital storytelling for their teaching and learning tasks, this study focused on an in-depth implementation and evaluation of digital storytelling by a small number of carefully selected teachers who have the ability to meaningfully integrate technology into their respective curricula. Two private Basic Education schools (6–15 years) in Qena were chosen for their public recognition of their use of technology. The two school administrations were contacted and were supportive of the study, and provided access to the teachers and students.

Each of the selected two schools is equipped with a computer lab provided by the USAID funded Partners for Competitive Egypt (PfC) Project and each lab equipped with twenty-four networked PCs with Internet connection, digital camera, scanner and color inkjet printer. Each lab has a media specialist to support teachers and students in the use of the computers and their peripherals. The lab schedule allows classroom teachers to use the lab 2–3 times a week for the purpose of technology integration into the curriculum.

In addition, a decision was made to choose teachers who received training in the use of technology in their teaching, and use technology more frequently in their classrooms. Four teachers of different subject matters (English, science, mathematics and social studies) were chosen from each school (a total of eight teachers) for the integration of digital

storytelling into the curriculum. A small number of teachers was used since a larger number of teachers would limit the study's ability to conduct an in-depth analysis and to obtain teacher trust and confidence. Each of the eight teachers agreed to nominate one class (35–45 students) in the Second Stage Basic Education (13–15 years old) to integrate digital storytelling into the curriculum during the second semester from February to May 2006.

A person-level orientation and group workshop on the integration of digital storytelling was found an appropriate approach to be used in the training of teachers. The objectives of individual orientations and workshops were:

1. Describe and understand storytelling as a teaching and learning tool.
2. Identify the elements of storytelling.
3. Explore the power of storytelling for the teacher, students, and their connection to subject matter.
4. Create a map and/or storyboard for production.
5. Use desktop production tools in the creation of a 3–5 min digital story.
6. Save on CD or the Web.

An orientation followed by a workshop was provided for teachers during the first two weeks of February 2006 about the importance of digital storytelling, developing and using it within the curriculum with actual curriculum-based examples, tools required to produce digital stories and the importance of involving students in the design process in a meaningful way and as active participants.

Description of digital storytelling classes

Within the last few years, a variety of non-linear applications have become available that can be used in the creation of classroom digital stories. One of these applications is Microsoft Photo Story 3 for Windows. Photo Story is available for free and helps students create video stories from their photos, captured using a digital camera or downloaded from the Web. In a few simple steps, students can import and edit their photos one at a time, insert titles, record narration, add background music, specify locations for zooming and panning and add visual and transition effects.

Students can talk about a photo for as long or as little as they like. When they are done, they click the mouse button to go to the next photo (Fig. 1). The authoring task is done when they complete the last photo. Students can then save their stories in WMV (Windows Media Video) format and use any program that plays WMV files, such as Windows Media Player, to playback their stories.

Since a vital requirement for a successful digital storytelling authoring tool is that it takes students' skills into account, the initial feedback from the orientation and workshop revealed that teachers and students liked Photo Story and found it interesting and easy to use to tell the story of their photos. Although these features were made available by using commercially available software, such as Adobe Premier, these authoring environments are very costly and too complex for students.

To demonstrate the impact of digital storytelling in student learning, teachers were encouraged to help their students to conduct their digital stories in regular classroom settings at the computer lab. Although the physical placement of computers in a lab is in rows and does not encourage interaction among students, the advantage to the computer lab is that it offers a reduced student-to-computer ratio. Since creating a digital story requires skills and concepts that teachers need to teach, teachers introduced their students to the digital storytelling concept, equipment and software resources required to develop digital

Fig. 1 MS Photo Story 3

stories. Teachers showed the students how to use the digital camera, the scanner or Google Images to get pictures and import them to Photo Story with text and audio. In addition, sample digital stories were completed by the teachers to provide first hand experience in exactly what the students would be expected to complete. Robin's (2005) four-step approach to creating and integrating digital stories into learning was introduced to help groups create, review and evaluate their stories (Table 1).

First, teachers began by dividing their students into small groups and have each group brainstorm the story topic they would like to do based on the school curriculum. Each group of students began by selecting a topic, event, concept, theory or problem from the book that was the most exciting or most important in shaping a story and writing down a summary of the topic. Second, each group was asked to bring pictures using the digital camera or from the Web.

Third, students were encouraged to develop scripts by sketching storyboards, writing descriptions and arranging them to show the story sequence. Groups were advised to cooperate in all aspects of the design process, assign a job for each member in the group (e.g., photographer, technical assistance, developer, etc.) and review and discuss their stories and offer comments to improve the quality of the content and design. Collaboration among groups was emphasized also to share knowledge and improve design skills. All groups were scheduled to meet with the teacher or the researcher so they could receive personalized feedback regarding their projects.

Students were allowed three days to complete each of the activities. When the stories were completed, teachers attached a computer to a LCD projector so groups could present, discuss and reflect on the stories. A compilation CD of the digital stories was burned for each class to be shared with other classrooms and members of the school community so they could learn about the project and provide feedback on the stories.

Instruments

The evaluation instruments below were used to assess the quality of students' stories, student level of engagement in authentic learning tasks, teachers' concerns and views towards the use of digital storytelling.

Table 1 Robin's approach to creating and integrating digital stories

Steps	Procedures
1. Define, collect and decide	• Select a topic for your digital story • Create a folder on the desktop where you can store the materials you find • Search for image resources for your story, including: pictures, drawings, photographs, maps, charts, etc. • Try to locate audio resources such as music, speeches, interviews, and sound effects • Try to find informational content, which might come from web sites, word processed documents, or PowerPoint slides • Begin thinking of the purpose of your story
2. Select, import and create	• Select the images you would like to use for your digital story • Select the audio you would like to use for your digital story • Select the content and text you would like to use for your digital story • Import images into Photo Story • Import audio into Photo Story • Modify number of images and/or image order, if necessary
3. Decide, write, record and finalize	• Decide on the purpose and point of view of your digital story • Write a script that will be used as narration in your digital story AND provides the purpose and point of view you have chosen • Use a computer microphone and record the narration of your script • Import the narration into Photo Story • Finalize your digital story by saving it as a Windows Media Video (WMV) file
4. Demonstrate, evaluate and replicate	• Show your digital story to your peers • Gather feedback about how the story could be improved, expanded and used in your classroom • Help other groups how to create their own digital story

Student digital story evaluation rubric

The purpose of this evaluation is to assess student performance in digital storytelling in order to explore the extent to which students are engaged in authentic learning tasks via the development, presentation and sharing of digital stories. Literature shows that authentic assessment instruments are found appropriate to evaluate ICT-based learning projects and individual and group presentations. One such instrument is the scoring rubric.

A scoring rubric is a type of scoring scale that provides scaled levels of achievement or understanding for a set of criteria of quality for a given type of performance such as an essay or presentation (Allen and Tanner 2006). However, it is distinguished from ordinary scoring checklists by its more extensive definition and description of the criteria of quality that characterize each level of accomplishment.

No valid and reliable scoring rubric instrument was found that could be applied to evaluate student performance in digital storytelling. Therefore, the need was emphasized to construct and validate a scoring rubric to evaluate the quality of students' completed digital stories using indicators in several categories.

Overall, Moskal (2003) recommended six traits that should be considered in developing scoring rubrics: (1) the criteria should be clearly aligned with the requirements of the task and the stated objectives; (2) the criteria should be expressed in terms of observable product characteristics; (3) scoring rubrics should be written in specific and clear language; (4) the number of points that are used in the scoring rubric should make sense; (5) the

separation between score levels should be clear; and (6) the statement of the criteria should be fair and free from bias.

In addition, Mertler (2001) suggested a seven-step framework for developing analytical scoring rubrics for classroom use. Based on Moskal's six traits, the objectives of this study and Mertler's framework, the pedagogical and technical attributes of digital stories and their influence on student learning were revealed. These attributes are (1) Point of view; (2) Content; (3) Resources; (4) Curriculum alignment; (5) Organization; (6) Student cooperation; (7) Camera and images; (8) Titles and credits; (9) Sound; (10) Language; (11) Pacing and narrative; and (12) Transitions and effects.

In order to ensure that the proposed rubric is appropriate to the desired purpose, construct-related evidence is examined. In order to gather validity evidence, the accuracy and suitability of the rubric attributes to measure the determined criteria were examined based on experts' views and experience in the field of study. A panel of five reviewers was asked to review the literature-derived standards, together with the proposed attributes of evaluation, report on attributes and their characteristics they though were essential and critical to evaluate the quality and effectiveness of digital stories, suggest related attributes of evaluation, and comment on the alignment among the rubric attributes and the digital story standards.

This feedback led to fine tuning of the descriptors for the attributes in the rubric. The final attributes and their characteristics were reconstructed and represented in a twelve-attribute scoring rubric with a five point scale: Poor = 0; Low = 1; Moderate = 2; High = 3; and Exceptional = 4 for greater discrimination within the scale. Points 1 and 3 were provided as intermediate points for convenience of the observer.

In addition, to provide reliability evidence, five reviewers (three university assistant professors and two teachers), who had pedagogical and technical experience in teaching and using multimedia and digital storytelling, were asked to rate a sample of six digital stories in different subjects independently using the revised rubric. All were experienced in the development and use of scoring rubrics. The scores assigned by the evaluators for the stories were correlated to test for scorer reliability. The results show that most of the correlation coefficients (r = .22–.75) reported are statistically significant at 0.1 or .05. However there seems to be disagreement in the scoring of the stories by two university professors at .01 or beyond.

In addition, the correlation between the scores for the twelve attributes and the total score were obtained, suggesting that the matrices of inter-correlations for scores on the six stories assigned by the evaluators are significantly correlated at 0.01 or 0.05. Generally, the results tend to suggest internal consistency in the rubric attributes. This further validates the identified attributes as essential criteria in the scoring rubric.

Integration of the technology observation instrument

To examine further the quality of student engagement in authentic learning tasks using digital storytelling, a set of indicators for engaged learning and high-performance technology should be used. According to Painter (2001), the development or selection of such a set of indicators is based on teacher's and student's behaviors that should be observed to indicate the successful integration of technology in this setting. A good observation instrument must reflect carefully thought out attributes of technology integration and focus on the use of the intended technology by the teacher and students.

WestEd (2002) developed an observation instrument to collect data about the quality of technology integration into the curriculum as an evaluation component of the Arizona State

University Preparing Tomorrow's Teachers to use Technology (PT3) grant. To help observers interpret and record the same events (instrument reliability), the instrument provided an explicit set of instructions to the observer. In addition, the indicators to effective technology use were based on valid standards of technology integration (instrument validity). These standards are the National Educational Technology Standards for Teachers (NETS-T) and the National Educational Technology Standards for Students (NETS-S) as proposed by the International Society for Technology in Education (ISTE 2003). This instrument was subjected to a number of tests of reliability and internal consistency with the field samples.

The instrument contains three different forms: pre-observation form (e.g., lesson description), timed interval observation sheet (e.g., how are students working: alone, pairs, small groups, whole class), and post-conference form (e.g. obstacles to use the technology). The timed interval observation sheet is divided into several components: class organization, teacher role, teacher's use of technology, student use of research, productive and interactive technology, and students' level of technical skills. Time-linked data in the second form is analyzed for the percentage of time each variable is observed in the classroom. To collect data, the observer checks off the presence of various attributes of technology integration observed during three-minute intervals. The check marks for the noted intervals are then tallied for an overall distribution of observed events.

Interview for the evaluation of the effectiveness of digital storytelling

To integrate digital storytelling into learning, teachers must view it in a positive manner, be comfortable with it and use it effectively (Rakes and Casey 2002). Therefore, the need is emphasized to determine what teachers are thinking about when they are using digital storytelling and what they are concerned about at the end of the adoption process.

To gain a thorough understanding of the integration of digital storytelling into learning and provide richer detail and insights into teachers' experiences, a set of interview questions for individual interviews, as qualitative methods, were asked of each teacher in order to provide consistent data. These questions are framed to determine the perceptions of the teachers around issues of digital storytelling integration into learning.

Individual interviews, which were conducted during and after the period of implementation, were conducted in person by the researcher, and data were analyzed to identify patterns, beliefs, values and practices, as related to the teachers' digital storytelling integration. Questions that were asked of participants included:

- What is your view of digital storytelling?
- How much time is devoted to technology integration?
- What positive features of digital storytelling approach were you able to identify at the end of the implementation period?
- How do you perceive your role as a teacher to integrate digital storytelling?
- Did students use technology as planned? Describe.
- Do you think digital storytelling positively or negatively influences student learning? Describe.
- What obstacles did you face in using digital storytelling with your students and how can they be overcome?

Results of the study

The results are organized to address the research questions.

To what extent can students be engaged in authentic learning tasks with digital storytelling?

The final digital stories that were developed by groups included many topics in many subject matters. In English language, as a second language, one group developed a story (The Weather) in which they used the past perfect tense throughout the story to refer to actions that took place and were completed in the past. The action in this story was the heat wave that occurred last summer and its effect on the students' holidays.

A second group produced an interesting story around the topic the modern history of Egypt (Statues and Figures) using digital photos of famous squares in Egypt. In this story, students focused on the statues of many key figures in the modern history of Egypt (e.g., Mustafa Kamel) that are seen in famous squares across the country. Students began their story as follows: 'all of us know these squares but not all of us know these historical figures and their roles in politics and the economy'.

A third group created a story of a girl (her name is Amal, which means 'hope' in Arabic) who could not see the chalkboard or distance objects clearly and went to the optician who prescribed distance glasses to correct blurred distance vision. This story was linked to a science lesson entitled 'the nearsightedness'. The optician prescribed distance glasses to correct the blurred distance vision of Amal.

A fourth group developed a story around the life of Pythagoras, one of the first Greek mathematical thinkers. In this story, students explained that in a right triangle, the sum of the squares of the two right-angle sides will always be the same as the square of the hypotenuse then told the story of a real-life application of this Pythagorean Theorem in building construction (Fig. 2).

To assess the extent to which students were engaged in authentic learning using digital storytelling, the Student Digital Story Evaluation Rubric was used to assess student-produced digital stories. A total number of 65 stories were developed by students in different subject matters (Table 2).

Each story was evaluated using the rubric since the project was relatively small and so it was feasible to examine all the stories. The researcher and three participant teachers, who received training by the researcher in using the rubric, evaluated students' stories. To improve consistency between evaluators, a sample of students' products was evaluated for practice and to enhance agreement among evaluators. Scores for each story were analyzed and represented as a set of averaged ratings, one per criterion, and summarized as a final average covering the twelve criteria used in the rubric (Table 3).

Evaluation of students' stories shows that overall, students did well in their projects and their stories met many of the pedagogical and technical attributes of digital stories. Students' stories varied in length and quality, but most stories were about 5 min long. Most groups were able to state very good points of view for their stories that contributed to the overall meaning of the stories, even if these points did not connect clearly with each part of the story. However, fewer number of groups provided clear evidence of connection between the objectives of their stories and the objectives of the subject matter, suggesting that not all the other students may learn from these stories.

Fig. 2 Samples of student-produced digital stories

Table 2 Number of stories in each subject

Subject	Number of stories
Mathematics	10
English language	14
Science	18
Social studies	23
Total	65

However, although their content is accurate to some extent and relevant to the theme of the topics represented in the stories, stories showed very little variety in the sources and types of information. The majority of students used only pictures from the Internet (or using their digital cameras) and few words are presented as text, instead students used narration with very personal connections with the topic.

In terms of student cooperation, no clear evidence was apparent that students worked collaboratively in preparing their stories. The content, design and presentation of stories indicated that usually one student, and sometimes two students, actively participated in preparing their stories and those students did not reflect awareness of others' views and opinions in their presentations.

In terms of story organization, the results showed that planning and storyboarding occurred in most cases, scenes showed some variety in length, and pace was somewhat consistent but could be distracting in some instances. Elements were mostly consistent from scene to scene but some stories did not seem to have a beginning, middle or end.

Table 3 Ratings of students' stories ($N = 65$)

Criteria	Poor	Average	Good	Very Good	Excellent	Mean of rating	SD
1. Point of view				✔		3.12	.9164
2. Content			✔			2.45	.6621
3. Resources			✔			1.83	.8210
4. Curriculum alignment				✔		3.11	.6155
5. Organization				✔		2.74	.5936
6. Student cooperation		✔				1.36	.5396
7. Camera and images				✔		3.40	.6324
8. Titles and credits				✔		2.51	.5624
9. Sound			✔			1.69	.4937
10. Language				✔		3.05	.8372
11. Pacing and narrative				✔		2.86	.7881
12. Transitions and effects				✔		3.49	.6155
Final score				✔		2.63	.1845

In terms of the technical design of the stories, overall, the stories produced by the students demonstrated that they made use of the technical features of PhotoStory creatively, in order to enhance the presentation of their stories. The results showed that pans and zooms were mostly smooth, but may be inappropriate or distracting, and used too frequently. Titles and credits were well chosen and presented, legible and drew the viewer's attention. The biggest challenge for students was the timing or tight integration between the audio and image tracks. In a significant number of stories it was found that sound is cut-off, unclear, inappropriate to the content or inconsistent with titles and transition effects.

How effective is the digital storytelling approach for supporting teachers to effectively integrate technology into learning?

Classroom integration of digital storytelling was observed to provide a picture of the actual implementation practices used by teachers and students, contribute to the validity of the data collection and provide additional perspectives to the research. The observation tool focused on variables such as teacher and student roles, the nature of student work and the level of student engagement.

Observation of teacher and student roles in the eight classes indicated that although teachers spent a lot of time using grouping in flexible ways to take advantage of computer availability and meet the objectives of storytelling integration, a minority of students (20%) worked in groups most of the time. Those students took greater responsibility for their group projects and did collaborate effectively with their peers. However, the majority of students (75%) had some organizational and management difficulties in working together as a small learning community to plan, organize and develop their stories.

Although students worked without direct teacher assistance and the role of the teacher was that of a facilitator and consultant to students, it was clear that a significant number of groups (40%) asked their teachers to provide them with ideas for their stories and more instructions for locating images and resources to help them in creating their stories.

In addition, it was observed that teachers were not technically proficient in the use of Photo Story and other multimedia editing packages, and could not explain all the technical and organizational procedures to use the computer and other peripherals to produce digital stories. On many occasions, teachers asked their students to contact the computer teacher for technical assistance.

Across all the observations, it was clear Photo Story has made it easy for students to become involved and active participants in their own learning process. All of the students found the software easy to use and liked to use it in other subjects, if it was made available.

Although students had no a prior knowledge in multimedia authoring and authoring tools, students who had adequate technical skills did more collaboration and communication, carried out more work and many of them utilized multimedia helper applications (for photo and audio editing) and digital resources directly (such as the Web and audio and photo libraries) to develop their projects rather than analogue resources, (such as books and photos). However, it was also observed that many students were able to develop their technical skills through their planning activities and the translation of their ideas and resources to the digital format.

In addition, it was noticed that student motivation and engagement in story development projects based on the subject matter increased and student ICT skills became more developed. Subjects, such as science and history, are likely to have a convincing effect on student activity and engagement in developing their stories. These subjects were higher-level and cognitively challenging to engage students in learning and encouraged them to search for information, images and audio clips for their digital stories. However, the majority of students engaged in relatively long-term activities (2–5 days) and over 80% of groups completed their stories over the course of one week.

Despite the time spent on class management, advising students and helping them to cope with the new approach, most class time was spent on relevant and productive activities by teachers and students. Students did well in their projects, which was demonstrated by the stories presented at the end of the implementation period and they were satisfied with their ability to tell the story of their photos and watch them. These results are consistent with high marks for their stories as assessed using the digital story evaluation rubric.

What are the teachers' concerns and views regarding the implementation and integration of digital storytelling into learning?

The interviews were all recorded and transcribed. A process of coding was used to interpret and reduce the responses. This was undertaken through the use of a spreadsheet using a two-stage process. First, each separate point made was highlighted, and, second, a summary comment was generated to capture the point made. These comments were then reduced further to give rise to a coding framework of three themes. These themes were (a) teachers' concerns regarding the implementation of digital storytelling into learning, (b) the effectiveness of digital storytelling in student learning, and (c) advantages and limitations of digital storytelling integration.

In terms of teachers' concerns regarding the implementation of digital storytelling, teachers stressed the challenge of time as a big issue that should be considered in technology integration plans. They believed that the storytelling approach requires a considerable time by teachers to plan and prepare lessons. They agreed that even students spent a long time learning how to use the software appropriately, find appropriate resources to put them in the Photo Story and benefit from the production process on achievement.

Regarding the effectiveness of digital storytelling, interview data suggested that digital storytelling enriched the classroom learning environment, the curriculum, and student learning experiences by providing an open-ended, creative and motivating productive tool in the classroom. In addition, teachers perceived students to be motivated and excited to use the computer, digital camera, the Internet and Photo Story to develop their stories, particularly in connection with real world problems.

However, the interviewer noticed that many teachers were worried about the quality of student work or the direct relationship between the ideas behind student-produced stories and the objectives of the subject matter. The interviewer found that teachers focused on specific lesson objectives, not whole class instruction. In other words, teachers did not emphasize a short-term effect of digital storytelling in student academic performance, which is based usually on their grades in exams.

At the same time, teachers believed that the digital storytelling projects could increase students' understanding of curricular content and improve their technical, collaboration and communication skills as they engage in long-term storytelling projects. Many teachers observed that students helped each other out as they learned to develop their story or solve a problem for their story and were more willing to work together on their projects. Overall, there were no weaknesses noted by teachers in digital storytelling as a technology-oriented approach and five out of eight teachers were willing to transform their pedagogy and curriculum to include digital storytelling.

Lastly, data gathered from teachers revealed that teachers and students faced many technical and computer difficulties and need more technical assistance to use technology in the classrooms. In addition, teachers indicated that the lack of equipment (such as computers, digital cameras, scanners) and limited access to the Internet discourage teachers and students from successfully using the technology.

Discussion and implications

The findings from the analysis of students-produced stories suggest that students were encouraged to think more deeply about the meaning of the topic or story and personalize their experience and also clarify what they knew about the topic before and during the process of developing and communicating their stories. The well-chosen points of view, unconventional content and varied resources indicate that students did not just report facts and concepts connected to the subject, but reflected on their own thoughts and engagement with the subject, visually and aurally. Students learned to think and write about people, places, events and problems that characterized their individual life experiences or others' experiences.

Despite distracting digital effects and inadequate preparation and delivery of voice and images that appeared in student work, it seems that students enjoyed the idea of piecing together their thoughts and connecting them any which way they wanted to by titles, audio, narrations, motions, transitions and other Photo Story effects. These findings also indicate that digital storytelling provided a unique opportunity for students to acquire new media literacy and IT skills including capturing and editing digital photos, recognizing different image formats, recording and using audio clips, searching the Web for text and images and using Photo Story to edit, produce and save their stories for playback in their computers or VCD/DVD players

In addition, digital storytelling provided a real way to help students learn how to use technology effectively in their learning, particularly if provided with appropriate digital

resources and usable editing tools to further motivate them into creating quality stories. Developing repositories for digital learning resources and freeware that demonstrate an understanding of the existing needs of Egyptian students can help them store, access, share and reuse quality stories (Sadik 2006).

Observations and interviews revealed many aspects of the classroom environment and activities that best facilitate digital storytelling integration and support engaged learning. The findings revealed that students enjoyed the use of digital cameras, searching Web resources, authoring by Photo Story and playing with other non-linear editing tools to create short stories about what they really think and later to watch them. Students demonstrated a pride in the digital stories they were accomplishing and dedicated more time to the tasks required to bring images, audio and text into a storyboard and how to sequence and link them according to their stories.

However, the findings suggest that there is a need to encourage teachers to provide students with more long-term and problem-solving opportunities to spend sufficient time working and thinking together and build their own learning communities to create and present their digital stories. Jonassen (2003) concluded that the key process to most story problem instruction is worked examples of problem solutions in multiple forms. The worked examples of problems must emphasize each of the processes for parsing the verbal problem representation and categorizing the problem type using the conceptual model.

In addition, traditional assessment methods, which may not reflect what students learn with technology, should be replaced by appropriate assessment strategies which help teachers to look for evidence of deeper understanding. One possible solution, for example, is to use digital storytelling as an e-portfolio tool of formative assessment for learning. Using digital storytelling as a reflective portfolio gives more opportunities for learners to collect, organize, reflect and communicate evidence of their learning with others, which is an essential component of classroom work and can raise standards of achievement more effectively than any other strategy. This use, furthermore, can strongly influence student cognitive development and accomplish the long-term goals of technology integration into learning (Jonassen et al. 1999; Gils 2005).

In addition, research is needed to discover obstacles which prevent such reflection in informal learning communities and how these obstacles might be more easily overcome in many subject matters, like mathematics and science, through digital storytelling. Although many teachers believe that technology integration is more trouble and a difficult and time-consuming endeavor, it does result in improved learning and teaching. For example, teachers can look at digital storytelling as a new way to humanize the teaching and learning of science and bring the beauty and power of mathematics to learners.

In addition, the professional development of teachers should provide continuous opportunities for teachers to align technology with the curriculum and collaborate and learn from peers who integrate technology into the teaching of other subjects. Consistent with the integrated curriculum approach, the professional development of teachers can benefit from digital storytelling to help teachers to make the connection between the subject they teach and other subjects to provide a more meaningful context for learning. Moreover, digital storytelling can be used to encourage teachers themselves to prepare their own stories about their classrooms and students and connect with peers in other schools to build their own collaborative learning spaces.

References

Allen, D., & Tanner, K. (2006). Rubrics: Tools for making learning goals and evaluation criteria explicit for both teachers and learners. CBE—*Life Sciences Education, 5*, 197–203.

Barrett, H. (2006). Researching and evaluating digital storytelling as a deep learning tool. In C. Crawford, et al. (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2006* (pp. 647–654). Chesapeake, VA: AACE.

Bruner, J. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.

Combs, A., & Beach, D. (1994). Stories and storytelling: Personalizing the social studies. *The Reading Teacher, 47*, 464–471.

Dexter, S., Anderson, R., & Becker, H. (1999). Teachers' views of computers as catalysts for changes in their teaching practice. *Journal of Research on Computing in Education, 31*(3), 221–239.

Dorner, R., Grimm, P., & Abawi, D. (2002). Synergies between interactive training simulations and digital storytelling: a component-based framework. *Computers & Graphics, 26*, 45–55.

Duffy, M., & Cunningham, J. (1996). Constructivism: Implications for the design and delivery of instruction. In D. H. Jonassen (Ed.), *Educational communications and technology* (pp. 170–199). New York: Simon & Schuster Macmillan.

Earle, R. S. (2002). The integration of instructional technology into public education: Promises and challenges. *ET Magazine, 42*(1), 5–13. http://bookstoread.com/etp/earle.pdf. Retrieved 11 January 2007.

Gils, F. (2005). Potential applications of digital storytelling in education. In *3rd Twente Student Conference on IT*, University of Twente, Faculty of Electrical Engineering, Mathematics and Computer Science, Enschede, February 17–18.

Griest, G. (1996). Computer education as an obstacle to integration and Internet working. *Learning and Leading with Technology, 24*(8), 59–63.

Harris, J. (2005). Our agenda for technology integration: It's time to choose. *Contemporary Issues in Technology and Teacher Education, 5*(2). http://www.citejournal.org/vol5/iss2/editorial/article1.cfm. Retrieved 27 February 2007.

Herrington, J., Oliver, R., & Reeves, C. (2003). Patterns of engagement in authentic online learning environments. *Australian Journal of Educational Technology, 19*(1), 59–71.

Hoffman, B. (1997). Integrating technology into school. *Education Digest, 62*(5), 51–55.

ISTE (International Society for Technology in Education). (2003). National educational technology standards. http://www.iste.org. Retrieved 15 March 2006.

Jacobsen, M. (2001). *Building different bridges: Technology integration, engaged student learning, and new approaches to professional development*. Paper presented at AERA 2001: What We Know and How We Know It, the 82nd Annual Meeting of the American Educational Research Association, Seattle, WA, April 10–14.

Jonassen, D. H. (2003). Designing research-based instruction for story problems. *Educational Psychology Review, 15*(3), 267–296.

Jonassen, D. H., & Carr, C. (2000). Mindtools: Affording multiple knowledge representations in learning. In S. P. Lajoie (Ed.), *Computers as cognitive tools, Vol. 2: No more walls* (pp. 165–196). Mahwah, NJ: Lawrence Erlbaum Associates.

Jonassen, D.H., & Hernandez-Serrano, J. (2002). Case-based reasoning and instructional design using stories to support problem solving. *Educational Technology Research and Development, 50*(2), 65–77.

Jonassen, D., Peck, K., & Wilson, B. (1999). *Learning with technology: A constructivist perspective*. Upper Saddle River, NJ: Prentice Hall.

Jonassen, H., Wilson, G., Wang, S., & Grabinger, S. (1993). Constructivist uses of expert systems to support learning. *Journal of Computer-Based Instruction, 20*(3), 86–94.

Kafai, B., Ching, C., & Marshall, S. (1997). Children as designers of educational multimedia software. *Computers & Education, 29*(2–3), 117–126.

Lim, P., & Tay, Y. (2003). Information and communication technologies (ICT) in an elementary school: Students' engagement in higher-order thinking. *Journal of Educational Multimedia and Hypermedia, 12*(4), 425–451.

Lim, P., Nonis, D., & Hedberg, J. (2006). Gaming in a 3D multiuser virtual environment: Engaging students in science lessons. *British Journal of Educational Technology, 37*(2), 211–231.

Lynch, G., & Fleming, D. (2007) Innovation through design: A constructivist approach to learning. LAB 3000, RMIT University. http://lab.3000.com.au/research/research/index.jsp. Retrieved 5 March 2007.

Meadows, D. (2003). Digital storytelling: Research-based practice in new media. *Visual Communication, 2*(2), 189–193.

Mergendollar, J. (1997). Technology and learning: The research. *Education Digest, 62*(8), 12–15.

Mertler, A. (2001). Designing scoring rubrics for your classroom. *Practical Assessment, Research & Evaluation, 7*(25). http://PAREonline.net/getvn.asp?v=7&n=25. Retrieved 4 April 2007.
Moskal, M. (2003). Recommendations for developing classroom performance assessments and scoring rubrics. Practical assessment. *Research & Evaluation, 8*(14). http://PAREonline.net/getvn.asp?v=8&n=14. Retrieved 4 April 2007.
Nanjappa, A., & Grant, M. (2003). Constructing on constructivism: The role of technology. *Electronic Journal for the integration of Technology in Education, 2*(1). http://ejite.isu.edu/Volume2No1/nanjappa.htm. Retrieved 11 January 2007.
Office of Technology Assessment. (1995). *Teachers and technology: Making the connection*. Report Summary, U.S. Congress, Washington, DC: U.S. Government Printing Office. OTA-EHR-616.
Painter, R. (2001). Issues in the observation and evaluation of technology integration in K-12 classrooms. *Journal of Computing in Teacher Education, 17*(4), 21–25.
Papadimitriou, C. (2003). MythematiCS: In praise of storytelling in the teaching of CS and Math. In *The International Conference on CS Education, ITICSE*, Thessaloniki, Greece, July 2.
Pedersen, E. (1995). Storytelling and the art of teaching. *FORUM, 33*(1). http://exchanges.state.gov/forum. Retrieved 17 February 2008.
Pritchard, A. (2004). Introducing new students to ICT: Giving a purpose to it all. *Active Learning in Higher Education, 5*(3), 248–262.
Rakes, G., & Casey, H. (2002). An analysis of teacher concerns toward instructional technology. *International Journal of Educational Technology, 3*(1). http://www.ed.uiuc.edu/ijet/v3n1/v3n1articles.html. Retrieved 2 March 2007.
Richards, T. (1998). Infusing technology and literacy into the undergraduate teacher education curriculum through the use of electronic portfolios. *T.H.E. Journal, 25*(9), 46–50.
Robin, B. (2005). *Educational uses of digital storytelling. Main directory for the educational uses of digital storytelling*. Instructional technology Program. University of Huston. http://www.coe.uh.edu/digital-storytelling/default.htm. Retrieved 12 February 2007.
Robin, B., & Pierson, M. (2005). *A multilevel approach to using digital storytelling in the classroom.* Digital Storytelling Workshop, SITE 2005, University of Houston. http://www.coe.uh.edu/digital-storytelling/course/SITE2005. Retrieved 12 February 2007.
Roe, D., Stoodt, D., & Burns, C. (1998). *Secondary school literacy instruction: The content areas*. New York, NY: Houghton Mifflin Company.
Sadik, A. (2006). *From national challenges to a global community: establishing and implementing a low-cost learning object repository for Egyptian teachers*. Paper presented at the 2nd International Open & Distance Learning Symposium, 13–15 September, Anadolu University, Turkey.
Schiro, M. (2004). *Oral storytelling and teaching mathematics*. Thousand Oaks, CA: SAGE Publications.
Schofield, J. (1995). *Computers and classroom culture*. Cambridge, NY: Cambridge University Press.
SERVE. (1996). *Technology infrastructure in schools. Hot topic publication for the U.S. Department of Education, Office of Educational Research and Improvement*. Tallahassee, FL: SERVE.
Sheingold, K., & Hadley, M. (1990). *Accomplished teachers: Integrating computers into classroom practice*. New York: Center for Technology in Education, Bank Street College.
Spivey, N. (1997). *The constructivist metaphor: Reading, writing, and the making of meaning*. New York: Academic Press.
Stake, E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.
Standley, M. (2003). *Digital storytelling using new technology and the power of stories to help our students learn—and teach*. Cable in the Classroom. http://www.ciconline.org/home. Retrieved 5 December 2006.
Strommen, E., & Lincoln, B. (1992). Constructivism, technology, and the future of classroom learning. *Education and Urban Society, 24*, 466–467.
The Digital Storytelling Association. (2002). *The center for digital storytelling*. http://www.dsaweb.org. Retrieved 18 February 2007.
Trilling, B., & Hood, P. (1999). Learning, technology, and education reform in the knowledge age or "We're Wired, Webbed, and Windowed, Now What?" *Educational Technology, 39*(3), 5–18.
Tsou, W., Wang, W., & Tzeng, Y. (2006). Applying a multimedia storytelling website in foreign language learning. *Computers & Education, 47*, 17–28.
Tyner, K. (1998). *Literacy in a digital world.* Mahwah, NJ: Lawrence Erlbaum.
WestEd. (2002). *Preparing tomorrow's teachers to use technology (PT3), Integration of Technology Observation Instrument grant*. Arizona State University West. http://www.west.asu.edu/pt3. Retrieved 5 March 2006.

Wheatley, G. (1991). Constructivist perspectives on science and mathematics learning. *Science Education, 75*(1), 9–21.

Alaa Sadik is an assistant professor at Department of Instructional & Learning Technologies, Sultan Qaboos University, Oman. He worked as an educational technology consultant in the Partners for Competitive Egypt (PfC) project, funded by the USAID between 2003 and 2005. His current research interests include the effective integration of ICT into the curriculum in developing regions.