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Digital storytelling for enhancing student academic achievement, critical thinking, and learning motivation: A year-long experimental study

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A B S T R A C T

The purpose of this study was to explore the impact of Digital storytelling (DST) on the academic achievement, critical thinking, and learning motivation of senior high school students learning English as a foreign language. The one-year study adopted a pretest and posttest quasi-experimental design involving 110 10th grade students in two English classes. The independent variable was information technology-integrated instruction (ITII) on two different levels – lecture-type ITII (comparison group) and DST (experimental group). Both quantitative and qualitative data were collected, including English achievement and critical thinking scores, questionnaire responses for learning motivation, as well as recordings of student and teacher interviews for evaluating the effectiveness of DST in learning. Descriptive analysis, analysis of covariance (ANCOVA), multivariate analysis of covariance (MANCOVA), and qualitative content analysis was used for evaluating the obtained data. Our findings indicate that DST participants performed significantly better than lecture-type ITII participants in terms of English achievement, critical thinking, and learning motivation. Interview results highlight the important educational value of DST, as both the instructor and students reported that DST increased students' understanding of course content, willingness to explore, and ability to think critically, factors which are important in preparing students for an ever-changing 21st century.

1. Introduction

21st century learning takes place in a rapidly changing and technology-suffused environment. Key characteristics of this environment include access to an abundance of information, increased classroom availability of emerging technologies (e.g., mobile learning devices, online applications, and social media tools), and the capacity to collaborate and contribute on an unprecedented scale (Malita & Martin, 2010; Robin, 2008). Researchers and practitioners in this new millennium face the challenge of preparing and equipping learners with the skills required for 21st century citizenship. Publications by the Partnership for 21st century skills (2004) and other researchers (e.g., Crane et al., 2003; Eisler, 2006; Robin, 2008) have advocated a focus on core subjects, critical thinking, and learning motivation, along with information literacy.

Seeking a synergy of technological advancements with developments in pedagogy, scholars have suggested that an ideal combination of technology-integrated learning and social constructivism is essential for attaining contemporary educational objectives (Koohang, Riley, Smith, & Schreurs, 2009; Neo & Neo, 2010; Sadik, 2008). Social constructivist principles highlight the importance of students' collaboration in using available tools and learning activities within an authentic environment in constructing and reconstructing ideas and beliefs (Vygotsky & Cole, 1978). Knowledge is not simply transmitted from instructor to student but is actively constructed by each student or group of students through their interactions with their physical, social, and technological environment (Fosnot, 1996; Prawat, 1996). Since technological devices are regarded as vital educational tools that can facilitate the co-construction of knowledge among students, many educators (Ayas, 2006; Dodge, 1995; Jonassen & Carr, 2000; Milson & Downey, 2001; Wheatley, 1991) have proposed information technology-integrated instruction (ITII) strategies based on social constructivist theory.

IT integrated learning is an important approach for contemporary educators which influences teaching, learning, curriculum, and materials (Wang & Li, 2000). However, ITII is often incorrectly applied in actual practice due to a lack of knowledge or skills in technology-supported pedagogy (Hew & Brush, 2007; Sulčič & Lesjak, 2009) required for planning and integrating technology into teaching.

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Technology-supported pedagogy may be classified into three categories in which technology functions as: (a) replacement, (b) amplification, or (c) transformation (Hughes, 2005). Technology as replacement involves technology serving as a different means to the same instructional goal, such as when an instructor presents a poem on a PowerPoint slide instead of writing the poem on the blackboard. Technology as amplification involves the use of technology to accomplish tasks more efficiently and effectively without altering the task (Pea, 1985). For example, when students conduct peer review using word processors rather than by hand, the author's ability to efficiently make revisions is enhanced. Finally, use of technology as transformation has the potential to provide innovative educational opportunities (Hughes, 2005) by reorganizing students' learning content, cognitive processes, and problem solving activities (Pea, 1985) or instructors' instructional practices and roles in the classroom (Reinking, 1997). However, instructors are often accustomed to employing technology in familiar and convenient ways (Hughes, 2005; Zhao, Pugh, Sheldon, & Byers, 2002), often focusing on the delivery of course content rather than innovative instructional strategies. As such, instructors may use PowerPoint slides instead of paper-based textbooks when explaining course content, which is an example of lecture-type ITII. In this case students are still passively listening to lectures, instead of actively engaging in the learning process, experiencing feelings of ownership, and taking responsibility for their learning.

Among technological advancements influencing education, the availability of advanced, low-cost, and user-friendly digital cameras and multimedia editing software (e.g., iMovie, Movie Maker, and Photo Story) offers great potential for innovative teaching and learning. These multimedia authoring and presentation tools are valid constructive tools for transformative student learning which emphasizes production, thinking, collaboration, and project management (Sadik, 2008). Instructors are able to provide comprehensive knowledge that will inspire reflective thinking for crafting transformative technology pedagogy and provide ideas and alternatives for technology use (Hughes, 2005).

Digital storytelling (DST), taking advantage of these advancements in technology and instructional design, is becoming a promising transformative technology-supported approach for enhancing learning, including subject matter content acquisition, critical thinking skills, motivation, and information literacy. Since constructing a successful DST project requires instructors to pose problems that are deeply connected with the course content, students are challenged with thinking critically about effective combinations of content and multimedia elements while considering the audience's perspective. At the same time, digital stories allow opportunities for student control of the learning process and self-expression, fostering learning confidence, task value; and learning motivation. Each story challenges students to meticulously select and edit artifacts, from personal products to other multimedia resources that meaningfully support the story and learning goals, thereby developing technology and media skills (EDUCAUSE Learning Initiative, 2007). However, research studies have not yet explored the effectiveness of different levels of ITII, such as lecture-type ITII and DST. Therefore, this study explores the impact of different levels of ITII on students' learning experiences.

1.1. Digital storytelling (DST)

Porter (2005) suggests that Digital storytelling (DST) "takes the ancient art of oral storytelling and engages a palette of technical tools to weave personal tales using images, graphics, music, and sound mixed together with the author's own story voice." Several studies have shown that DST goes beyond the capabilities of traditional storytelling by generating student interest, concentration, and motivation, facilitating student collaboration and organization of ideas, helping students to comprehend complex learning content, and presenting knowledge in an adaptive and meaningful manner (Robin, 2005, 2008; Sadik, 2008; Van Gils, 2005). By providing systematic instructional procedures, convenient free-use software, and objective evaluation, DST constitutes a meaningful approach for energizing instructors and motivating students.

DST provides a clear procedure that helps instructors design instructional activities easily, based on the "learning by doing" immersion method of constructivism. The essence of storytelling consists of the following four phases: 1) pre-production; 2) production; 3) post-production; and 4) distribution (Chung, 2006; Gere, 2002; Kearney, 2009; Ohler, 2005; Robin, 2005). Pre-production includes five steps: a) posing questions in authentic scenarios, b) exploring topical information, c) writing the script and eliciting peer review, d) performing oral storytelling, and e) designing a story map and storyboard. At the beginning of class, the instructor poses certain questions about a topic based on contexts or experiences related to the students' lives and interests in order to encourage participants to consider alternatives and decide upon a topic. Next, students research the topic for information to write scripts which reflect a logical story or sequence of events. After completing the scripts, they question each other, engaging in peer critiquing or coaching. Students first practice telling their stories in a traditional manner, which aids in the discovery of details essential to their stories. Afterward, a story map (Fig. 1) is designed to illustrate the main components of the story and their relationship to the overall narrative. For instructors, story mapping provides a basis for immediate assessment of students' stories and provides feedback on how to improve weaker elements of their stories. In addition, students represent their stories in a storyboard format (Fig. 2), arranging the sequence of scenes, effects, and other digital components. Each task in this pre-production phase is paper-based, requiring focus on the content rather than multimedia elements. Writing scripts and story treatments is a key process for creating digital stories since the final product is media-based.

During the production phase, students prepare multimedia elements and record their own voices. Then, in the post-production phase, the content is arranged and edited into a digital story. During the distribution phase, students share their comments and digital stories with others. The dynamic process of creating digital stories develops a deeper connection with the subject matter being learned as well as relevant extra-curricular experiences.

1.2. DST and academic achievement

In order for innovative technology-supported instructional strategies to be considered appropriate and permanent options for instructors, their influence on students' academic performance must be evaluated. Researchers have examined the effectiveness of DST in increasing students' academic achievement. In terms of language learning, researchers (Ellis, 1993; Gomez, Arai, & Lowe, 1995; Schank, 1990; Tsou, 2003) have demonstrated that, at an early stage of language acquisition, academic achievement correlates positively with the oral behaviors of repeating, chanting, and singing. In fact, telling and listening to stories shapes early learning and can even influence the nature of our intelligence (Schank, 1990; Tsou, 2003). In particular, the effectiveness of DST has been demonstrated for developing listening comprehension skills in elementary school English as a second language learners (Tsou, Wang, & Tzeng, 2006; Verdugo & Belmonte, 2007). The authors suggest that future studies should include alternative age groups and explore other linguistic

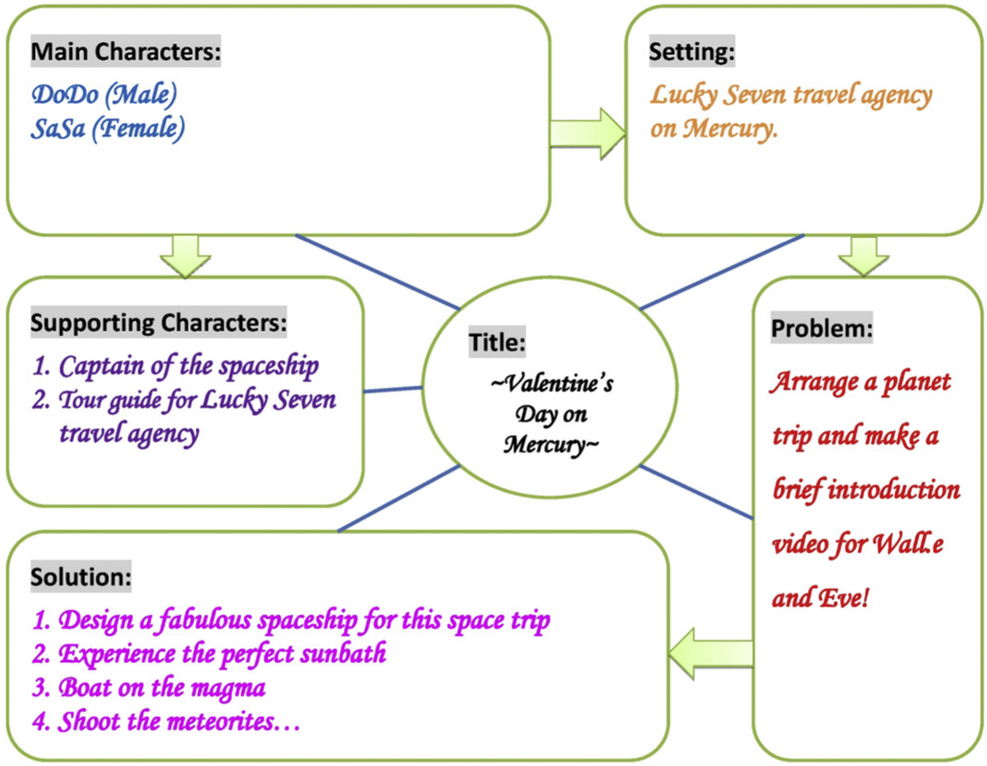
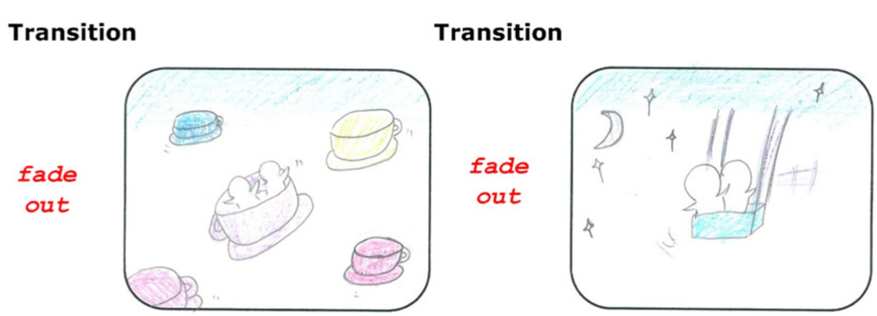


Fig. 1. Story map.

areas such as reading and writing, which could further substantiate the link between a media-rich environment and language learning. Hence, exploring the impact of DST on academic achievement in different linguistic areas (listening, reading, and writing) was the first goal of this research.

1.3. DST and critical thinking

Another main application of DST is in enhancing students' critical thinking, which scholars since Dewey (1910) have emphasized as a major goal for education. The American Psychological Association (APA) offers a general definition of critical thinking as "judging in



Time (sec.)	25 sec.	30 sec.
Effects	Slow-motion	Slow-motion & Colorful pictures
Music/ audio	She (Elvis Costello)	
Script	The dust on Mars makes the storm stronger. When the dust is in the sunshine, the sunshine raises its temperature. As a result the speed of the storms will be faster…	You can take the sky tram in the largest volcano in the Solar System - Olympus Mons…relax and enjoy the beautiful starry sky…

Fig. 2. Storyboard.

a reflective way what to do or what to believe" (Facione, 1990, 112). In the context of contemporary information overload it is increasingly necessary to cultivate students' critical thinking for evaluating the authenticity of claims from among a mass of online information (Yang, Newby, & Bill, 2008). Five measurable dimensions which reflect this critical thinking ability include recognition of assumptions, induction, deduction, interpretation, and evaluation of arguments (Yeh, 2003).

When students create their own digital stories, they gather evidence to support the plot, empathizing with similar difficulties which they may face in their daily life, and project these problems onto characters in the story. Sims (2004) suggests that the process of listening to and telling stories includes many critical elements, as storytellers must use critical thinking such as deductions and interpretations to persuade their audience. In creating their own digital stories, students ultimately make decisions and overcome the characters' problems by using a critical theorizing process and reflection skills (Benmayor, 2008; Maier & Fisher, 2006; Malita & Martin, 2010), suggesting that DST may an effective instructional strategy for improving students' critical thinking. Although critical thinking has been identified as an important instructional goal, little research on the impact of DST on critical thinking has been conducted. Therefore, the second goal of this study was to explore the impact of DST on critical thinking.

1.4. DST and learning motivation

Engaging and motivating students is always a key factor for successful learning. Research has shown that the application of technology improves student learning motivation and performance in technology-rich classrooms (Jonassen, 2000; Roblyer & Edwards, 2000), including those adopting ITII strategies. However, since students are very familiar with technology, is lecture-type ITII sufficient for activating their learning motivation? Recent research has emphasized that instructors also need to design meaningful activities for enhancing students' interest and motivation in order to promote active learning (Chang, 2005; Pintrich & Schunk, 2002; Svinicki, 2004).

DST usually provides students with authentic scenarios suited to their personal experiences, making the content seem important and valuable. After successfully completing challenging tasks, students who are actively involved in learning will gain confidence and motivation (Koohang et al., 2009; Neo & Neo, 2010). Thus, DST stresses two motivational constructs: task value and self-efficacy for learning. Task value typically refers to students' judgments on the interest, usefulness, and importance of the course content (Pintrich, Smith, Garcia, & Mckeachie, 1993), while self-efficacy refers to the judgment of one's capability to perform an academic task (Pintrich, 1999). Hence, the third goal of this study was to compare the effectiveness of lecture-type ITII and DST in fostering learning motivation.

2. Purpose of the study

Although instructors are often encouraged to use ITII strategies based on social constructivism to conduct effective learning, most instructors still struggle to integrate technology into regular class activities. In fact, technology is often applied simply to replacement or amplification uses. This implies that instructors have not been adequately trained in developing transformative technology pedagogy and are inexperienced in matching appropriate teaching materials and technology tools to course content. This study examines the potential gap between DST and lecture-type ITII by comparing innovative instructional technology strategies for engaging students in active learning and construction of knowledge in the classroom. More specifically, this research intends to empirically investigate the following research questions:

1. Will there be any difference in academic achievement between classes taught under different levels of ITII (lecture-type ITII and DST)?
2. Will there be any difference in critical thinking between classes taught under different levels of ITII (lecture-type ITII and DST)?
3. Will there be any difference in learning motivation between classes taught under different levels of ITII (lecture-type ITII and DST)?

3. Method

A pretest and posttest quasi-experiment design involving an experimental group and a comparison group was used in examining the above research questions. The research design is shown in Fig. 3.

3.1. Participants

One hundred and ten participants were recruited from two 10th grade English classes at a comprehensive senior high school in Taiwan. For both classes, students' entrance exams results were below the national average. The proportion of male to female students was approximately 1:2. Both classes utilized the same course content, instructor, schedule, and examinations but were taught using two different instructional strategies. One class, with 56 students, was taught with ITII and served as the comparison group, while the other class, with 54 students, was taught using DST and served as the experimental group. Students were divided in to eight 7-person heterogeneous groups based on their English proficiency.

3.2. Independent variable

The independent variable in this study was ITII on two levels: lecture-type ITII (comparison group) and DST (experimental group). Lecture-type ITII refers to the instructor providing course content-based lectures for the majority of the class, applying technology such as computers, projectors, and presentation software, as instructional aides. Students studied individually for paper-based homework/tests and occasionally engaged in group discussions. On the other hand, students in the experimental group participated actively in completing DST projects. That is, students combined images, graphics, music, and sound together with their own voices to create coursework related projects. After an explanation of the course content, students were guided in following the four phases of DST (see Fig. 1) for collaboratively creating digital stories. The class activities and allocation of time for the two levels of ITII are shown in Table 1.

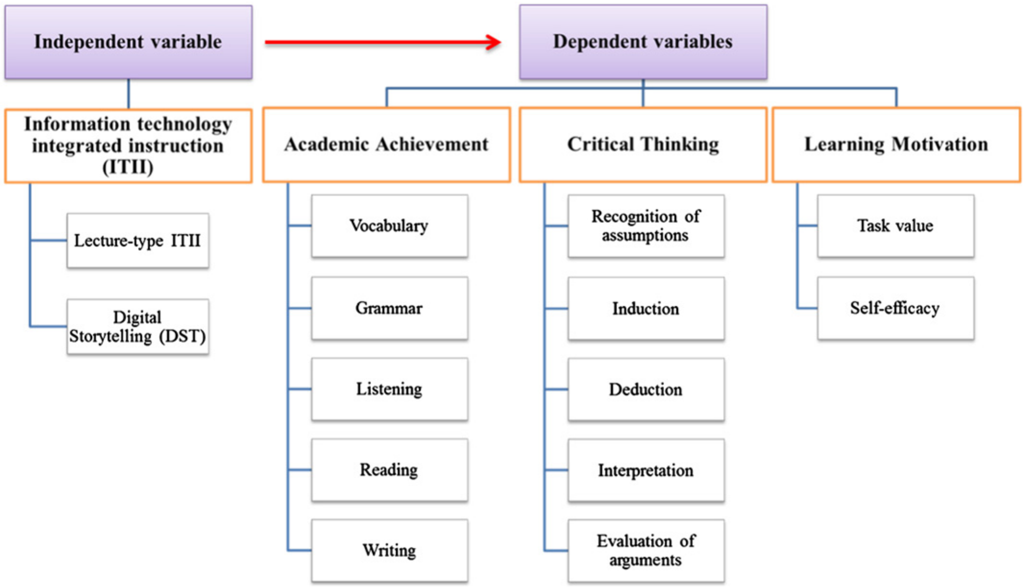


Fig. 3. Research design.

3.3. *Dependent variables*

The three dependent variables evaluated by this study were students' academic achievement in English, critical thinking skills, and learning motivation. These variables were measured by three tests as described below.

An English achievement test (EAT) was developed, based on the course content, by the researchers and instructor to examine students' academic achievement. Content/expert validity was achieved through the cooperation of an experienced instructor and one Education Ph.D. student who had majored in English. The EAT consisted of five parts: vocabulary, grammar, listening, reading, and writing. Apart from the writing component, the other four sections were comprised of multiple choice questions. The sub-total for each section was 20, with a total score of 100. The writing section involved telling stories from pictures and students were asked to write a 100-word essay based on two pictures about traditional festivals. Writing was evaluated based on the General English Proficiency Test (GEPT) Level 1 Writing Rubric, on a scale from 0 (not stated) to 5 (correct expression and few errors in grammar or use of words). Miles and Huberman's (1994) inter-rater reliability formula was used to calculate inter-rater reliability. After two 6-h training sessions, two raters, the instructor and a doctoral student, separately evaluated 10 students' writing tests. The inter-rater reliability was 90%, which met Miles and Huberman's general standard of 90%.

The Critical Thinking Test-Level I (CTT-I) (Yeh, 2003) included a total of five subscales (recognition of assumptions, induction, deduction, interpretation, and evaluation of arguments). Each subscale included 5 multiple choice questions. The total score on each subscale was 5; therefore, the total score for the test was 25. The overall Cronbach's α of the CTT-I was .76.

The Motivated Strategies for Learning Questionnaire (MSLQ) (Wu & Cherng, 1992) was used in evaluating participants' learning motivation and strategies. This test is scored on a 6-point Likert scale, from 1 (not at all true of me) to 6 (very true of me). In this study, a total of 11 items from two relevant MSLQ subscales were used: 6 items for task value and 5 items for self-efficacy for learning (see Table 2) were adopted. The Cronbach's α of these two subscales were .91 and .89, respectively. Moreover, the correlation between these two subscales and other motivational subscales of the MSLQ was .17–.79, which demonstrates overall internal consistency and construct validity.

Table 1
Class activities and time allocation for the two levels of ITII.

Class activities	Comparison group (lecture-type ITII)	Time allocation	Experimental group (DST)	Time allocation
Instruction	Instructor provides leading questions.	5%	Instructor provides leading questions.	5%
	Instructor presents course content with PowerPoint & textbook.	75%	Instructor presents course content with PowerPoint & textbook.	5%
Student tasks	Students collaborate on team work.	10%	Students collaborate on DST project (including four phases: pre-production, production, post-production, and distribution)	70%
Student presentations	Students present their team work.	5%	Students present their DST project and post it to the class blog, accessible for a global audience.	10%
	Instructor provides feedback on students' presentation.	5%	Whole class provides feedback for the DST presentations.	10%

Table 2
Questions from the two MSLQ subscales.

Task value		
Interest	1	I am very interested in the content area of this course.
	2	I like the subject matter of this course.
Importance	3	It is important for me to learn the course material in this class.
	4	Understanding the subject matter of this course is very important to me.
Usefulness	5	I think I will be able to use what I learn in this course in other courses.
	6	I think the course material in this class is useful for me to learn.
Self-efficacy		
7	I'm certain I can understand the most difficult material presented in the readings for this course.	
8	I'm confident I can understand the basic concepts taught in this course.	
9	I'm confident I can understand the most complex material presented by the instructor in this course.	
10	I believe I will receive an excellent grade in this course.	
11	I'm certain I can master the skills being taught in this course.	

3.4. Research procedures

Before starting the experiment, the researcher arranged several meetings and discussions to help the instructor understand the research procedures, including DST-based instruction, critical thinking, and strategies for learning motivation. The researcher and instructor then collaboratively designed 10-week lesson plans and class activities for first semester.

This study adopted a pretest and posttest quasi-experimental design with two research groups. Two classes met twice per week for 45 min sessions. The duration of the experiment was 22 weeks. For both research groups, students completed three tests (EAT, CTT-I, and MSLQ) as pretests at the beginning of the semester (week 1). Afterward, they completed the same three tests and interviews as posttests during week 22. The interviews were conducted in groups for about 15–20 min. The two topics adopted in this experiment were "Sky Lantern Festival" and "The Eight Planets," each of which lasted for 10 weeks. Table 3 presents the class outline, including DST activities for the experimental group.

Table 3
Class outline of the experimental group.

Week	DST activities
1	Pretest: EAT, CTT-I, and MSLQ
Topic 1: Sky Lantern Festival (Ws 2–11)	
(1) Pre-production phase	
2	(1–1) Pose questions and authentic scenario • Introduce DST procedures • Divide students into groups • Introduce vocabulary, grammar, and content • Show the self-made digital story
3	• Pose questions about the topic to students • Discuss questions • Set up an authentic scenario about traditional Chinese festivals (1–2) Explore topic information • Choose one traditional festival as the group topic for DST • Search for topic information
4–5	(1–3) Script & peer review • Compose the 1st draft of the story • Peer review • Revise the 2nd draft of the story
6–7	(1–4) Perform oral storytelling • Perform oral storytelling • Share comments about oral storytelling • Revise the final story draft (1–5) Design story map and storyboard
(2) Production phase	
7	(2–1) Search for images and audio (2–2) Record
(3) Post-production phase	
8–9	• Edit digital stories with Microsoft Photo Story 3
(4) Distribution phase	
9	• Upload digital stories to class blog • Watch digital stories online and write comments to others (Homework)
10–11	• Final oral report • Share reflections and comments • Provide a conclusion
Topic 2: The Eight Planets (Ws 12–21)	
12–21	The same process as topic 1 using different software (Microsoft Movie Maker)
22	Posttest: EAT, CTT-I, MSLQ, and interview

Table 4
Descriptive statistics for English academic achievement.

EAT (maximum score)	Comparison group					Experimental group				
	Pretest		Posttest			Pretest		Posttest		
	M	*SD*	*M*	*SD*	*Adj.M*	*M*	*SD*	*M*	*SD*	*Adj.M*
Vocabulary (20)	9.29	3.76	14.14	4.67	14.82	10.59	4.34	16.67	2.77	15.96
Grammar (20)	8.39	2.92	12.82	4.17	13.98	12.48	3.27	16.67	2.88	15.47
Listening (20)	12.05	5.46	9.73	5.43	10.29	10.65	5.32	14.26	4.99	13.68
Reading (20)	7.68	3.14	7.61	4.75	8.75	10.67	3.30	12.93	4.34	11.74
Writing (20)	3.14	4.40	1.76	4.03	2.35	8.86	6.08	11.29	4.72	10.68
Total score (100)	40.55	9.88	46.06	16.16	49.93	53.25	13.17	71.81	12.74	67.80

The instructional goals were the same for the two classes: helping students learn vocabulary, grammar, listening, reading, and writing skills and become familiar with the Sky Lantern Festival and other relevant traditional Chinese festivals. However, for the comparison group, the instructor lectured on the two topics through PowerPoint presentations and textbook readings. The students discussed the questions from the textbook and wrote a composition related to the topics as a collaborative homework. Finally, they presented their work in groups using presentation software.

For the experimental group, the instructor also used PowerPoint presentations and textbook readings to teach the same topics. Unlike the comparison group, the experimental group participants were assigned the task of collaboratively creating digital stories. Students were divided into groups of seven members based on the design of duties for DST-related tasks. The researcher emphasized the importance of group collaboration at the beginning of the first week, at which time individual duties (e.g., script writer, photographer, and animator) were selected and written on a group collaboration sheet. Students were informed that their final scores of projects would be evaluated by their contribution to the group, to encourage active participation.

Scaffolded use of technology was provided for the two DST topics. During topic one, when students possessed basic editing skills, Microsoft Photo Story 3 was used. For topic two, Microsoft Movie Maker was adopted, which allowed more advanced functions. An example of detailed instructional procedures and DST activities topic two, “the Eight Planets,” are described as follows. In the beginning (week 12), the instructor introduced DST procedures and discussed job assignments for the DST task, including responsibilities for writing, art design, acting, and film editing. The instructor also spent about 15 min briefly introducing key vocabulary, grammar patterns, and course content and showed a self-made digital story. In week 13, she posed some open-ended questions about the topic to stimulate discussion among the students. Sample questions include: “Why did there used to be nine planets in the Solar System, but now there are only eight?” and “Do you agree with excluding Pluto from the planets? Why or Why not?” Afterward, the instructor provided the students with an authentic scenario, a competition for designing a story for an international astronomy festival. Students then chose one planet they wanted to include in their digital story and searched for information on the topic via the internet.

The role of the instructor changed to that of a facilitator, monitoring the progress of each group and providing help only when needed, and students became active leaders from week 14 forward. They worked with group members and solved problems independently. During weeks 14 and 15, they composed the first draft of their story collaboratively and revised a second draft according to peer critiques. Each group made comments based on English vocabulary, grammar, the logic of the plot, and the content of the story.

In week 16, each group spent around 5 min performing their story script on a stage, then shared comments in order to revise and write the final draft. Group members then collaboratively designed story maps and storyboards according to the final drafts. Students searched for images and music, and then recorded all the multimedia data they needed in week 17. After that, they proceeded to the post-production phase: editing the digital stories with Microsoft Movie Maker. Each group was required to upload completed digital stories to the class blog, which was accessible to a global audience. Also, they needed to watch a total of seven digital stories and share comments with each other online as homework before the next classes (weeks 18 and 19).

During the last two weeks (weeks 20 and 21) each group presented their work on stage as a final report. The students were encouraged to share their reflections about the DST task, such as what difficulties they encountered and how they solved them, which parts/tasks they preferred and what interesting/exciting/depressing events occurred. Also, the instructor provided feedback and a conclusion about each group’s performance and what the students had learned during the previous ten weeks.

3.5. Data analyses

Both quantitative and qualitative data were collected for this study. Descriptive statistics were used to describe the means, standard deviations, and adjusted means for the three tests (EAT, CTT-I, and MSLQ) between the two groups. Next, analysis of covariance (ANCOVA) was used to compare the final learning results of the two research groups after 22 weeks of instruction, with pretest scores on the EAT, CTT-I, and MSLQ as covariates to eliminate the effect of any existing pretest differences on the results. Multivariate analysis of covariance

Table 5
ANCOVA summary table for English academic achievement.

SV	*SS′*	*Df*	*MS′*	*F*	*p*
Pretest EAT	5602.38	1.00	5602.38	34.50	.00*
Between (Group)	6727.71	1.00	6727.71	41.43	.00*
Within (Error)	17373.36	107.00	162.37		
Total	420220.00	110.00			
Corrected total	41194.10	109.00			

*$p < .05$.

Table 6
MANCOVA summary table for English academic achievement.

SV	*Df*	*SSCP′*	*Wilks' Λ*
Between	1	$\begin{pmatrix} 169.24 & 56.67 & 73.95 & 149.13 & 414.74 \\ 56.67 & 18.98 & 24.76 & 49.94 & 138.88 \\ 73.95 & 24.76 & 32.31 & 65.17 & 181.23 \\ 149.13 & 49.94 & 65.17 & 131.41 & 365.47 \\ 414.74 & 138.88 & 181.23 & 365.47 & 1016.41 \end{pmatrix}$	.62*
Covariances	5	$\begin{pmatrix} 274.82 & 249.02 & 238.81 & 282.06 & 153.22 \\ 249.02 & 305.93 & 305.36 & 263.51 & 130.66 \\ 238.81 & 305.36 & 366.88 & 315.90 & 118.64 \\ 282.06 & 263.51 & 315.90 & 434.37 & 206.21 \\ 153.22 & 130.66 & 118.64 & 206.21 & 162.04 \end{pmatrix}$	.56*
Within	103	$\begin{pmatrix} 2666.54 & 309.80 & 380.18 & 549.08 & 307.15 \\ 309.80 & 1300.93 & 648.03 & 554.30 & 385.94 \\ 380.18 & 648.07 & 1031.34 & 556.84 & 66.12 \\ 549.08 & 554.30 & 556.84 & 1806.70 & 337.14 \\ 307.15 & 385.94 & 66.12 & 337.14 & 1910.26 \end{pmatrix}$	

*$p < .05$.

(MANCOVA) and post hoc comparison (Bonferroni confidence intervals) were conducted to examine whether there was a significant difference in the subscales of the three posttests. From a qualitative perspective, interviews with the instructor and students were evaluated in terms of the outcome variables A content outline was applied to sort the interview data collected from questions concerning the participants' perceptions and experiences. Audio recordings were transcribed and analyzed through protocol analysis wherein categories were created using keywords, such as academic performance, critical thinking, or learning motivation.

4. Results and discussion

4.1. Academic achievement in English

Table 4 shows descriptive statistics, including means, standard deviations, and adjusted means, for English scores between the two research groups. Both research groups showed improvement on the posttest. However, the ANCOVA results show a significant difference in EAT posttest scores between the comparison group (lecture-type ITII group) and the experimental group (DST group), $F(1, 107) = 41.43$, $p = .00$, partial $\eta^2 = .28$ (see Table 5). Taking into account the partial eta squared of .28, we can conclude that DST had a significantly large main effect on academic achievement in English (Cohen, 1988, pp. 280–287; Richardson, 2011).

Additionally, the results of MANCOVA reveal that the posttest scores on the five subscales of the EAT differed significantly between the two research groups, *Wilks' Λ* = .62, $F(5, 99) = 12.01$, $p = .00$. Thus, an analysis of Bonferroni confidence intervals was conducted as a follow-up test (see Tables 6 and 7). The results of the post hoc comparison indicate that three subscales, listening, reading, and writing, differed significantly between the two research groups.

In terms of listening skills, the experimental group outperformed the comparison group, echoing the results of Tsou et al. (2006) and Verdugo and Belmonte (2007). DST students frequently listened to stories from their own team and their classmates and, during the pre-production and distribution phases, evaluated other groups' story drafts and oral storytelling presentations. In addition to completing their own final project in English, participants needed to fully understand the content of their classmates' presentations in order to provide suggestions and reflections to other groups. The pervasive use of the English language in task-related and interaction-based contexts provided ample opportunities for listening to not only stories (Schank, 1990), but directions and feedback for peers and instructors. In addition, DST participants were provided with state-of-the-art technology for voice recording and audio editing, as well as a collaborative and authentic environment wherein English listening was a valuable and productive skill, integral to cooperating toward the final goal of creating a digital story. As such, an emphasis on collaboration and production (Sadik, 2008) in the DST group, resulted in improved listening comprehension as compared to participants in the IT integrated instructional setting, who lacked similar opportunities for collaborative construction of meaning in authentic productive environments.

Concerning reading and writing skills, DST students engaged in both process-oriented (ie, story map construction and feedback notes) and product-oriented (ie, final script writing) tasks while completing their DST projects. Within the DST framework, participants were active in collaboratively constructing the meaning of content-related themes by browsing, summarizing, and sharing several sources of English materials of varying degrees of length and complexity, in the process of composing their story drafts. During peer reviews, DST participants were required to not simply comprehend the authentic writing materials created by their peers, but to provide a critical perspective on their

Table 7
Post hoc comparison for subscales of English academic achievement.

Subscales	Comparison of groups	Mean difference	95% Confidence interval		Direction of difference
			Lower bound	Upper bound	
Vocabulary	E–C	1.14	−.70	2.98	E = C
Grammar	E–C	1.49	−.15	3.13	E = C
Listening	E–C	3.40*	.76	6.04	E > C
Reading	E–C	3.00*	.82	5.17	E > C
Writing	E–C	8.33*	6.10	10.56	E > C

*$p < .05$.

Table 8
Descriptive statistics for critical thinking.

CTT-I (maximum score)	Comparison group					Experimental group				
	Pretest		Posttest			Pretest		Posttest		
	M	*SD*	*M*	*SD*	*Adj.M*	*M*	*SD*	*M*	*SD*	*Adj.M*
Recognition of assumptions (5)	4.20	.82	4.30	.74	4.30	4.17	.72	4.33	.64	4.33
Induction (5)	3.86	1.09	4.00	.91	4.00	3.87	1.03	4.19	.85	4.19
Deduction (5)	4.14	.88	4.11	1.00	4.12	4.13	.87	4.33	.73	4.32
Interpretations (5)	3.32	1.18	3.46	1.22	3.42	3.02	1.16	3.83	.93	3.88
Evaluation of arguments (5)	2.48	1.13	2.48	1.25	2.46	2.17	1.09	3.28	1.12	3.30
Total score (25)	18.00	3.21	18.36	3.04	18.22	17.35	2.66	19.96	2.29	20.11

use of vocabulary, structure, logic and plot, by providing critical feedback in English. The use of a media-rich context for reading and writing, as suggested by Verdugo and Belmonte (2007), relied upon the use of multimedia sources such as images, videos, and sounds, which assisted learners in constructing knowledge required for English language composition and comprehension. That is, the scaffolding and structure incorporated by a multimedia approach to storytelling with DST allowed for a context in which both receptive and productive language competencies were exercised. While ITII also provided opportunities for technology-supported reading and writing, DST served as a transformative technology-supported pedagogy by successfully integrating English language learning in a constructivist context which valued and embraced collaboration, feedback, and self-production of authentic materials for a real audience.

Data from interviews with students and teachers assists in triangulating the quantitative findings with the perspectives of participants. These examples illustrate the perceived importance of an immersion environment for English language learning in which students collaborated in script writing and revision, leading to the production of a completed digital story. The following examples of the instructor's and students' responses for the experimental group (where S refers to student responses, I is used for instructor feedback) are provided:

> I: "DST was an integrated instructional strategy for helping students learn English. I required them to use English during the whole class while doing DST. This was not easy for 16-year-old students, but at least they tried their best. Their progress was shown in their English grades. The other class (the comparison group) also made progress, but to a lesser degree."

> S1: "In order to search for information on the topic, I read lots of English materials and wrote them into our script. I think my English reading and writing skills have improved!"

> S2: "The content was difficult, and I had to read several scripts when proceeding with the peer review. Revising scripts for each group really improved my English abilities."

The fact that no significant differences were found between the research groups in terms of vocabulary and grammar scores suggests that DST group performed as well as the lecture-type ITII group, despite a greater emphasis on project-based learning rather than memorization and testing. For the lecture-type ITII group, for example, the instructor used technology, such as PowerPoint, to present and reinforce vocabulary and grammar patterns, asking students to read aloud and memorize the new vocabulary and grammar patterns. As such, ITII group participants spent more time writing practice tests, while the instructor introduced vocabulary and grammar items briefly for the DST group before students began working on their projects. Thus, the DST group, who were expected to write completed scripts with precise vocabulary and accurate grammar, were responsible for negotiating the meaning of vocabulary and grammar patterns through their experiences and interactions with curricular content in the process of designing and revising their stories. While both groups scored similarly in tests of grammar and vocabulary, it is arguable that the DST group was offered a more meaningful environment for using these elements of language.

4.2. Critical thinking

Descriptive statistics for critical thinking skills (measured by the CTT-I) are shown in Table 8. The ANCOVA results indicate a significant difference in critical thinking scores between the comparison group and the experimental group, $F(1, 107) = 17.07$, $p = .00$, partial $\eta^2 = .14$ (see Table 9). An effect size of .14 is considered large by Cohen's (1988, pp. 280–287) guidelines.

In addition, the results of MANCOVA reveal that posttest scores on the five subscales of CTT-I differed significantly between the two research groups, *Wilks'* $\Lambda = .85$, $F(5, 99) = 3.45$, $p = .01$. Thus, an analysis of Bonferroni confidence intervals was conducted as a follow-up test (see Tables 10 and 11). The results of the post hoc comparison indicate that two subscales, interpretation and evaluation of arguments, differed significantly between the two groups. These significant differences suggest that the DST project helped students develop overall critical thinking, particularly concerning activities targeting students' interpretation and evaluation of arguments.

Table 9
ANCOVA summary table for critical thinking.

SV	*SS′*	*Df*	*MS′*	*F*	*p*
Pretest CTT-I	178.13	1.00	178.13	31.42	.00*
Between (Group)	96.77	1.00	96.77	17.07	.00*
Within (Error)	606.65	107.00	5.67		
Total	41176.00	110.00			
Corrected total	855.67	109.00			

*$p < .05$.

Table 10
MANCOVA summary table for critical thinking.

SV	*Df*	*SSCP'*	*Wilks' Λ*
Between	1	$\begin{pmatrix} .03 & .16 & .17 & .37 & .68 \\ .16 & .98 & 1.06 & 2.35 & 4.29 \\ .17 & 1.06 & 1.14 & 2.53 & 4.60 \\ .37 & 2.35 & 2.53 & 5.64 & 10.26 \\ .68 & 4.29 & 4.60 & 10.26 & 18.68 \end{pmatrix}$	.85*
Covariances	5	$\begin{pmatrix} 7.38 & 7.42 & 4.05 & 3.58 & 4.32 \\ 7.42 & 14.72 & 9.47 & 14.36 & 9.51 \\ 4.05 & 9.47 & 9.17 & 8.89 & 3.19 \\ 3.58 & 14.36 & 8.89 & 26.21 & 9.74 \\ 4.32 & 9.51 & 3.19 & 9.74 & 10.54 \end{pmatrix}$	.53*
Within	103	$\begin{pmatrix} 44.46 & 2.25 & -4.87 & 5.53 & 2.48 \\ 2.25 & 69.43 & 6.20 & 10.32 & 5.71 \\ -4.87 & 6.20 & 74.19 & 17.32 & 1.92 \\ 5.53 & 10.32 & 17.32 & 101.22 & 21.23 \\ 2.43 & 5.71 & 1.92 & 21.23 & 142.28 \end{pmatrix}$	

*$p < .05$.

In terms of interpretation, improvement for the DST group may be partially due to the nature of storytelling tasks, in that authors are responsible for developing a plot and persuading others of the events depicted in their stories (Sims, 2004). The use of a story map (see Fig. 1) scaffolded students in the process of creating a logical structure for a digital story. Collaborative script writing and the creation of a storyboard (see Fig. 2), further enhanced the ability of participants to interpret the meaning of specific visual, audio, and textual features within the context of a cohesive and plot-driven structure. Additionally, the integration of software in organizing and editing multimedia story elements required a degree of familiarity with the instructional content and flexibility with the technology necessary for fostering critical reflection during the process (Hughes, 2005).

The use of DST for fostering decision critical reflection, which applies to the ability of interpreting elements of stories or dialogs, was highlighted by Malita and Martin (2010) in terms of resolving character conflicts and making decisions regarding plot elements. In this study, students were required to create special scenic spots on a planet and design meaningful activities for potential visitors during DST topic two. The Mars group designed a “high speed coffee cup and merry-go-round” activity for their trip. During the plot development and peer review process, groups demonstrated their efforts to logically interpret why this activity seemed reasonable or sensible. The narration developed for one group’s digital story is listed as follows (A and B denote the roles of two Mars tour guides in their story):

A: The speed of these storms on Mars is 500 kilometers per hour, five times faster than hurricanes on the earth.

B: The dust on Mars makes the storm stronger. When the dust is in the sunshine, the sunshine raises its temperature. As a result the speed of the storms will be faster.

A: That is why we are preparing the coffee cup and merry-go-round for you.

B: Do you want to experience such a high-speed feeling? This is a special chance for Valentine’s Day.

The use of peer review in the DST process was instrumental in fostering students’ performance in terms of evaluation of arguments. The use of DST required a great deal of interaction among peers in the process of revising and clarifying their stories, resulting in improvement in their interpretation and evaluation of argument skills, confirming the findings from previous studies (Benmayor, 2008; Maier & Fisher, 2006; Sims, 2004) which indicated that students require critical thinking to persuade their audience and make decisions on behalf of their characters.

Participants in the DST group learned to judge evaluate the information provided by either their own team members during the draft writing process and during peer reviews of project presentations made by other groups. In evaluating different sources of information or perspectives provided in a team environment, participants collaboratively constructed their understanding of which arguments or propositions were most suitable for their story, a “hands-on” approach for negotiating which ideas to accept or reject. When evaluating other groups’ scripts and presentations, they also made comments, recommendations, and provided explanations for their suggestions. In terms of the previous example, for instance, the Neptune group provided certain suggestions to the Mars group, such as “The activities of the high speed coffee cup and merry-go-round are interesting. However, how will you proceed with these activities? Where will you put the coffee cup and merry-go-round? Please explain in more detail.” Through this interactive peer review activity, both reviewers and presenters had opportunities to exercise their skills in interpretation and evaluation of arguments.

Table 11
Post hoc comparison for subscales of critical thinking.

Subscales	Comparison of groups	Mean difference	95% Confidence interval		Direction of difference
			Lower bound	Upper bound	
Recognition of assumptions	E–C	.03	−.22	.28	E = C
Induction	E–C	.19	−.12	.51	E = C
Deduction	E–C	.21	−.12	.53	E = C
Interpretation	E–C	.46*	.08	.84	E > C
Evaluation of arguments	E–C	.84*	.39	1.29	E > C

*$p < .05$.

Table 12
Descriptive statistics for learning motivation.

MSLQ (maximum score)	Comparison group					Experimental group				
	Pretest		Posttest			Pretest		Posttest		
	M	*SD*	*M*	*SD*	*Adj.M*	*M*	*SD*	*M*	*SD*	*Adj.M*
Task value (36)	26.23	4.05	25.09	4.54	25.67	28.54	3.37	29.43	3.83	28.83
Self-efficacy (30)	16.61	3.80	17.61	4.50	18.28	18.56	4.16	20.57	3.92	19.88
Total score (66)	42.84	6.72	42.70	7.90	44.01	47.09	6.20	50.00	6.80	48.64

Interview data was used to triangulate the findings from the quantitative data. The statements below reflect the emphasis of the peer review process (both internal, see S3, and external, see I and S4) in terms of fostering critical and reflective thinking as well as an emphasis on logic and reason:

I: "Training in critical thinking takes time. The peer review really helps students evaluate others' advantages and disadvantages, which is lacking in traditional English writing classes."

S3: "This (planet trip) is an interesting topic. We searched for planet information and imagined what activity could be held on that planet. The activities should be reasonable and logical."

S4: "Revising others' scripts was difficult. Sometimes I found what was wrong, but I needed to explain the reasons to the groups so that they could revise the script and make it more reasonable or realistic."

While scores on the other three subscales of critical thinking (recognition of assumptions, inductions, and deductions) were not significantly higher for the DST group than the comparison group, both received scores higher than 4.00 for these two subscales on the pretest and posttest (see Table 8). With a maximum score of 5 for each subscale, room for progress may have been limited. Since the results demonstrated that technology-enhanced learning effectively improved students' skills in the recognition of assumptions and deduction, a better result may require more explicit instruction in inductive reasoning or more sensitive measure of inductive and deductive reasoning skills. In the future, DST activities could be designed in which students must complete a story, basing their conclusions on the preceding facts, thus fostering induction.

4.3. *Learning motivation*

Table 12 summarizes descriptive statistics including means, standard deviations, and adjusted means for learning motivation, measured by the MSLQ. The mean scores of the experimental group were higher than those of the comparison group on both the pretest and posttest. The results obtained by ANCOVA indicated a significant difference in the total scores for learning motivation between these two groups, $F(1, 107) = 13.87$, $p = .00$, partial $\eta^2 = .11$ (see Table 13).

Moreover, the results of MANCOVA revealed that the posttest scores for the two subscales of MSLQ differed significantly between the two research groups, $Wilks' \Lambda = .86$, $F(2, 105) = 8.36$, $p = .00$. Thus, an analysis of the Bonferroni confidence intervals was conducted as a follow-up test (E and C refer to the experimental group and comparison group, respectively; see Tables 14 and 15). The results of the post hoc comparison indicated that both subscales, task value and self-efficacy, differed significantly between the two research groups.

DST provided students with a meaningful authentic scenario related to their personal experiences, wherein a dynamic and interactive process of creating and publishing digital stories aroused the students' motivation in a rich multimedia classroom (Jonassen, 2000; Pintrich & Schunk, 2002; Roblyer & Edwards, 2000).

In terms of task value, students noted that the technology skills learned during DST tasks were applicable to other classes, for example, art and computer class. Each storytelling task challenged students in using technology for selecting, editing, and presenting multimedia resources for meaningfully supporting the story and learning goals, thereby developing technology and media skills (EDUCAUSE Learning Initiative, 2007). When using English as the language for creating digital stories, learning English became a useful and valuable activity for the students. Additionally, within a collaborative working environment, students were able to focus on their individual roles within the group while recognizing their contribution to the overall effort in the form of a meaningful and authentic published story. For the comparison group, on the other hand, the application of technology for the purpose of replacement and amplification failed to alter the instructional goals/tasks, resulting in no significant improvement in student motivation.

In terms of learning self-efficacy, DST participants were aware that their stories could be viewed by others online, their interest and abilities are reinforced, thus motivating them to create their best work (Standley, 2003). From a constructivist perspective, when the teacher serves as a facilitator, students take responsibility for their learning, respond at their own pace, and learn actively. By completing digital stories collaboratively, students believed that they could master this complicated task and expected to perform well, which influenced their

Table 13
ANCOVA summary table for learning motivation.

	SS′	*Df*	*MS′*	*F*	*p*
Pretest MSLQ	1791.16	1.00	1791.16	46.83	.00*
Between (Group)	530.50	1.00	530.50	13.87	.00*
Within (Error)	4092.68	107.00	38.25		
Total	242971.00	110.00			
Corrected total	7350.26	109.00			

*$p < .05$.

Table 14
MANCOVA summary table for learning motivation.

SV	*Df*	*SSCP'*	*Wilks' Λ*
Between	1	$\begin{pmatrix} 246.81 & 125.15 \\ 125.15 & 63.46 \end{pmatrix}$	.86*
Covariances	2	$\begin{pmatrix} 331.66 & 389.60 \\ 389.60 & 801.76 \end{pmatrix}$	.52*
Within	106	$\begin{pmatrix} 1582.10 & 632.16 \\ 632.16 & 1124.81 \end{pmatrix}$	

*$p < .05$.

Table 15
Post hoc comparison for subscales of learning motivation.

Subscales	Comparison of groups	Mean difference	95% Confidence interval		Direction of difference
			Lower bound	Upper bound	
Task value	E–C	3.16*	1.62	4.70	E > C
Self-efficacy	E–C	1.60*	.30	2.90	E > C

*$p < .05$.

beliefs of self-efficacy (Koohang et al., 2009; Neo & Neo, 2010; Pintrich, 1999). While IT integrated instruction provides some advantages for student learning, the lack of a student-centered focus on technology for transformative learning limits the degree to which student learning motivation can be influenced. The advantage of DST is not only in the technology-infused environment for augmenting and supporting student learning and production, but also in the collaborative approach to problem solving, creativity, and goal-oriented learning which fosters student self-efficacy and satisfaction with the learning experience.

Interview data were used to substantiate and triangulate the quantitative findings. In fact, both instructor and student reports indicate that learning motivation was influenced by the incorporation of digital storytelling in the English language classes"

I: "I used to push my students to study English…this was the first time I tried to become a facilitator in class, and they performed well. Unlike the other class (comparison group), every student (in the experimental group) controlled the process of conducting DST and everyone was responsible for their own learning. They were so engaged!"

S5: "I felt confident when I finished the DST task with my group members."

S6: "Recording English narration is interesting! …I am willing to practice several times to make sure I can perform well."

S7: "I would like to have an English course this way afterwards! It is totally different from the way we used to learn English."

5. Conclusion

Digital storytelling (DST), as a transformative IT integrated instructional strategy, takes advantage of technological advancements, a clear production process and low-cost media materials, and an effective learning environment for fostering collaboration and co-construction of meaning. DST is a valuable tool for invigorating learning and motivating participants to collaboratively construct and personalize digital narratives as authentic products of learning. The results of this quasi-experimental study suggest that after 20 weeks of DST instruction, senior high school students demonstrated significant improvement in English proficiency, critical thinking, and learning motivation, especially for English listening, reading and writing (as measured by the EAT), interpretation and evaluation of arguments (as measured but the CTT-I) and task value and self-efficacy (as measured by the MSLQ). Furthermore, qualitative feedback from interviews with the instructor and students support the potential of DST as an approach for fostering collaborative second language learning in an environment that fosters higher order thinking and learning motivation.

While this study incorporated a quasi-experimental design for long-term evaluation of the dependent variables, certain limitations must be considered. First, while our use of a self-designed English Achievement Test accomplished the research goals of evaluating differences in English language acquisition between the two levels of instructional strategy (ITII and DST), the instrument has not been standardized by use with a larger sample, limiting the external validity of our findings. To address this limitation, we conducted interviews with the instructor and students. Future research should consider adopting a more rigorous approach to developing the content validity of academic achievement measures without sacrificing ecological validity, that is, through the use of standardized instruments (such as the MSLQ and CTT-I instruments used in this study). Concerning learning motivation, future research could also include additional subscales from the MSLQ, such as goal orientation and control of learning beliefs. Future studies in DST are recommended to recognize the value of qualitative as well as quantitative measures, and consider the role of learner affect and engagement in learning.

While instructional design based on social constructivist and IT integrated approaches for transformative learning have demonstrated the effectiveness of student collaboration in constructing and negotiating meaning, individual characteristics of these digital narratives, (ie, external and internal thinking styles), should be to be examined. Students with an external thinking style tend to be more extroverted and prefer to learn collaboratively, whereas students with internal thinking style are usually introverted and prefer to learn alone (Betoret, 2007; Sternberg, 1999). Thus, exploring the impact of different individual traits on the effectiveness of instructional strategies will aid researchers and instructors in modifying their instructional activities (e.g., collaborative vs. individual work) in providing adaptive instruction which accommodates individual students' needs.

Additionally, follow-up research is strongly encouraged to explore the influence of DST or other technology-integrated pedagogies in promoting 21st century skills, such as creative thinking, problem solving, and global literacy. As our study has demonstrated the potential for DST in terms of academic achievement in English as a foreign language classes, instructors and researchers should take confidence in designing a variety of courses with interesting and challenging digital storytelling strategies. With such effort, development of learning behaviors, including academic performance, higher order thinking, and learning motivation, will develop active learners who will be prepared for the sweeping changes of the future.

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