

VIRTUAL PUPPET STORYTELLING FOR IMPROVING LEARNING ACHIEVEMENT IN AN ELEMENTARY SCHOOL

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ABSTRACT. *This study aims to implement virtual puppet storytelling (VPST) in the classroom for enhancing elementary school students' learning outcomes and perception. VPST is a virtual show where the storyteller (teacher or student) can control two puppets with the left and right hands using a Leap Motion device to tell stories or lessons for educating students. The storyteller can control the head, hand, and body of these virtual puppets to perform stories. The educational results show that the students' learning outcomes of experimental groups are significantly higher than the control group in overall post-test scores ($t = -5.236$; $p = 0.000$) and perception questionnaire ranking scores: perceived ease of use ($t = -2.207$, $p = 0.036$), perceived usefulness ($t = -2.869$, $p = 0.008$), and attitude toward using ($t = -2.927$, $p = 0.009$). Thus, VPST is appropriate for helping students understand learning stories and enhance students' attention and perception. Also, the conclusion described the practical implications of VPST for educational aspects.*

Keywords: Virtual puppets, Storytelling, Elementary school

1. Introduction. Several studies have been conducted on puppet use benefits to enhance learning with preschool elementary and secondary school children. Still, little research was undertaken to use virtual puppets in content classes at the preschool, school, or college. However, recent studies [1] suggested integrating technology and multimedia into the classroom in an elementary school and [2] proposed to use digital storytelling in both school and college. Thus, this study proposes to use virtual puppet storytelling in the school to investigate its benefits in students' learning outcomes and perceptions. Further, in the method and result part, this study applied the cognitive theory of multimedia learning [3] to designing VPST and explaining results from VPST use in the classroom.

VPST is a virtual show on a computer screen in which the teacher or storyteller can control two puppets using a Leap Motion device. The left and right puppets are governed by the left and right sides of the storyteller, respectively. VPST is used to convey a lesson or story for educating students.

This study experimented at an elementary school to teach social studies, religion, and culture course. The participants are fourth- and fifth-grade students. They were split randomly into two groups: the experimental group and the control group. The experimental group learned with VPST, whereas the students of control group study with traditional storytelling. Moreover, the experimental examinations are a paper-based exam for pre-test and an immediate exam using a QR-code answer card for the immediate post-test.

2. Literature Review.

2.1. Virtual puppets and digital storytelling. Virtual puppets or digital puppets are a new technology that is used for making a virtual show or storytelling. Because of recent technological developments virtual puppets are now at a lower cost than physical puppets, can be created to represent several objects such as a person, animal, and cartoon, and can be exported to other platforms (e.g., webpage and mobile web/application). However, little research investigates the benefits of virtual puppets used for storytelling; almost all research was conducted using physical puppets. Therefore, the discussions and conclusions of this study are following the same well-known research of physical puppets. The use of physical puppets was wide for storytelling, such as in the study of [4,5], and [6] using traditional puppets and [7] demonstrating human's fingers to act like puppets. Physical puppet storytelling can motivate students interested in the learning selection or topic, provide help with public speaking, and enhance vocabulary lessons [5]. Moreover, the propose of [8] reveals five educational uses of puppets. These proposed uses include 1) creating classroom communication, 2) encouraging a positive learning environment, 3) increasing creativity, 4) fostering group working, and 5) changing learner's attitudes.

Digital storytelling is an activity that tells stories with a variety of digital objects and media for educational or other purposes, and it can be used to teach topics in many different learning areas [2]. For example, the educator used digital stories for three major types: 1) personal narratives – reports that provide a unique experience of one's life, 2) history documentaries – stories that help us understand the historical events, and 3) a particular concept – stories that inform or instruct the reader on a specific idea or practice in content areas such as science, and education technology [9].

2.2. Multimedia learning and its benefits for an elementary school. In human memory, the research of [5] found that humans have two channels for processing verbal and pictorial material from multimedia learning. Meaningful learning occurs when learners focus on relevant material, organizing it into a coherent representation, and integrating it with relevant prior knowledge. Additionally, there are three cognitive processes required for meaningful learning: selecting – humans must pay attention to relevant material, organizing – humans must organize selected words and pictures into coherent mental representations, integrating – humans must connect material representations with each other and with their prior knowledge. However, a human can process only limited amounts of material in each channel at any one time.

The research in an elementary school classroom of [10] concluded that today's elementary school students are a digital native learner who usually learns from a multimedia instruction. Their brain processing can accommodate more new knowledge when they receive verbal and pictorial multimedia. Moreover, the study of [1] promoted using multimedia in the elementary school classroom to enhance the lesson and practice an exercise.

Based on the virtual puppets, digital storytelling, and multimedia learning this study developed VPST for educating students because VPST is an easy way to create stories with less expensive and easier to deploy into the classroom.

3. Method. The experiment was conducted at an elementary school in Thailand. The participants in the experiment consist of a total of thirty-eight fourth- and fifth-grade students. This experiment separated students randomly into two groups: the control group (CG) and the experimental group (EG) for nineteen students. However, two EG students did not complete the post-test and then the EG have a final participant member at seventeen students.

Figure 1 shows three main activities of this study: 1) class orientation, introducing to QR-code answer card for the post-test response, and pre-test, 2) experimental treatment (using traditional storytelling for the control group and VPST for experimental group),

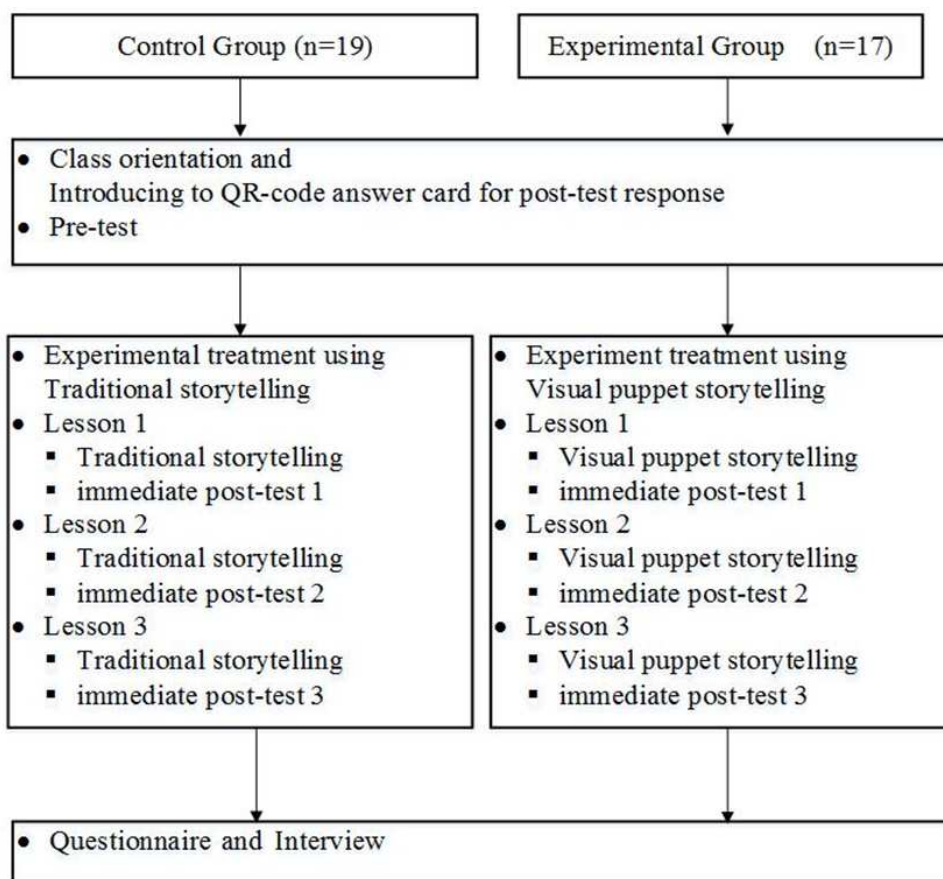


FIGURE 1. Flowchart for experimental procedures

three learning lessons and three immediate post-tests and 3) experimental questionnaire and interview.

There are three learning activities in this experiment: traditional storytelling, virtual puppet storytelling, and immediate post-test answering. Details regarding the activities explain as follows.

1) Traditional storytelling: The teacher tells stories for students using lesson slides.

2) Virtual puppet storytelling: The teacher sets up a virtual theatre by choosing a properly puppet and background to tell stories. Also, the teacher presents the lesson slides at the same time with the virtual puppet show. The activity is shown in Figure 2.

3) Immediate post-test answering: The students answer immediate post-test using QR-code cards and the cards will be read by the Plickers mobile application. The activity is shown in Figure 3.

The learning contents are Thailand’s important days which consist of three stories, that is, “New Year’s Day”, “Songkran Festival”, and “Loy Krathong Day”. These three stories are contained in social studies, religion, and culture course at elementary schools in Thailand.

This study had three variables which compared the pre-test and immediate post-test, also overall learning achievement between the group of control and experimental students: 1) Pre-tests are the scores that students took them before class starts for evaluating their prior knowledge. The pre-test items are ten multiple-choice questions, 2) Immediate post-tests are the quick tests that students took them after finishing each study lesson. The immediate post-test has 30 multiple-choice questions (each lesson 10 queries) and, 3) Overall scores are the total score of immediate post-tests. This study separates the leaning contents to three lessons because there are three learning topics as mentioned above and this study needs to analyze data three times for the three lesson scores and



FIGURE 2. VPST classroom

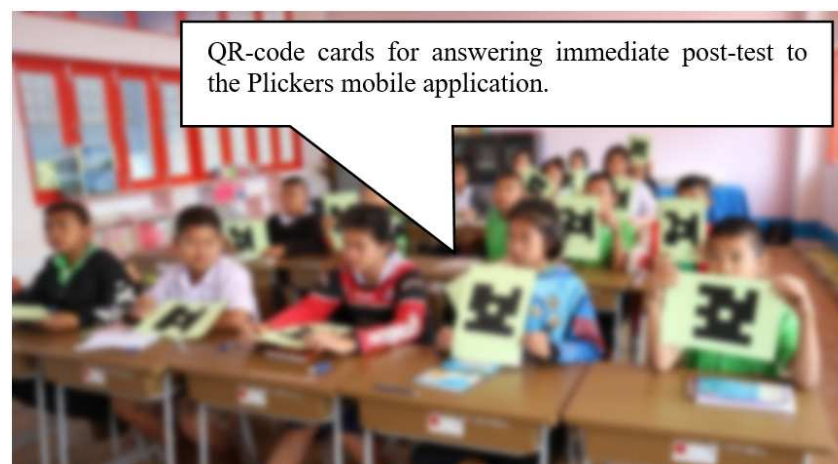


FIGURE 3. Immediate post-test answering

one time for the overall score to confirm the study results are acceptable statistics. The samples of pre-test and immediate post-test questions are shown as follows: 1) Sample question 1, which year did the Thai people start celebrating New Year's Day on January 1st? [A. 2484, B. 2485, C. 2486, D. 2487], 2) Sample question 2, when is the National Day of Elderly or Senior Citizens celebrated? [A. April-13, B. March-10, C. October-16, D. December-31], 3) Sample question 3, what is the Thai official song for New Year celebration? [A. New year greeting song, B. Thai national anthem, C. Auld Lang Syne song, D. New year song], 4) Sample question 4, when is the Songkran festival celebrated? [A. April 13-15, B. Mid of April, C. First week of April, D. End of April], and 5) Sample question 5, why Thai people carry handfuls of sand to their neighborhood monastery during the Songkran festival? [A. To be auspicious life., B. To recompense the dirt that they have carried away on their feet during the rest of the year., C. To use the sand for constructing the monastery., D. No matter meaning].

For the experiment tool design, the VPST application was developed using Unity for creating the game structure and Blender for building a 3D model. Figure 4 shows a VPST animator subprogram which has three modules. 1) Head module is a module for

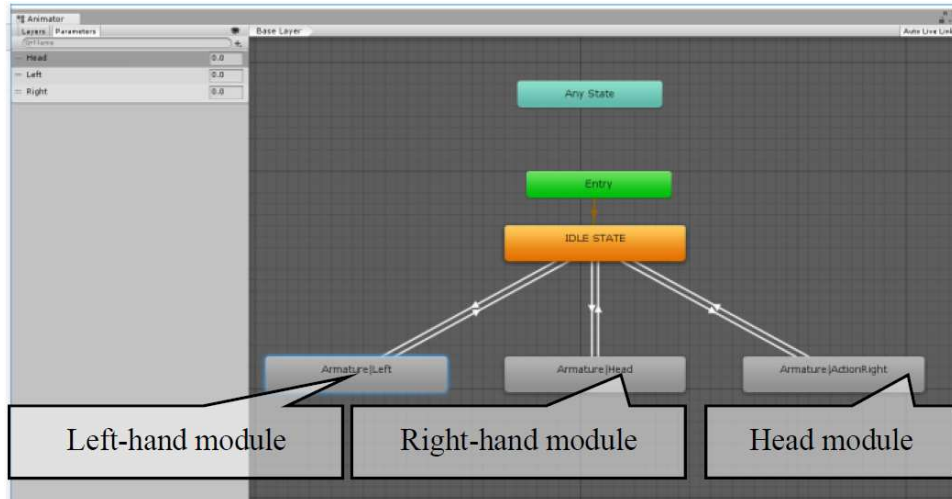


FIGURE 4. VPST animator subprogram

controlling virtual puppet’s head and mouth. 2) Left-hand and 3) Right-hand module is a module which controls left-hand and right-hand of this puppet, respectively.

The VPST application was connected to a hand gesture detector called Leap Motion for control of virtual puppet moving, as shown in Figure 5. The storyteller can control the head, hand, and body of these virtual puppets to perform stories. The left and right puppets are controlled by the left-hand and right-hand of the storyteller, respectively. The storyteller can use the VPST with a chosen background to create lessons or stories for educating students.



FIGURE 5. Hand controlling of VPST

Figure 6 shows the GUI of the VPST application. A user can click a button at the top left corner to change the background and click on the body of a virtual puppet to change the 3D model. Additionally, the VPST application can show or hide a virtual hand by choosing the checkbox at the bottom left corner and a user can click the home button to exit application.

The teacher and student can use the VPST as the following five steps: 1) open application and navigate to the home screen, 2) choose a background, 3) select first and second

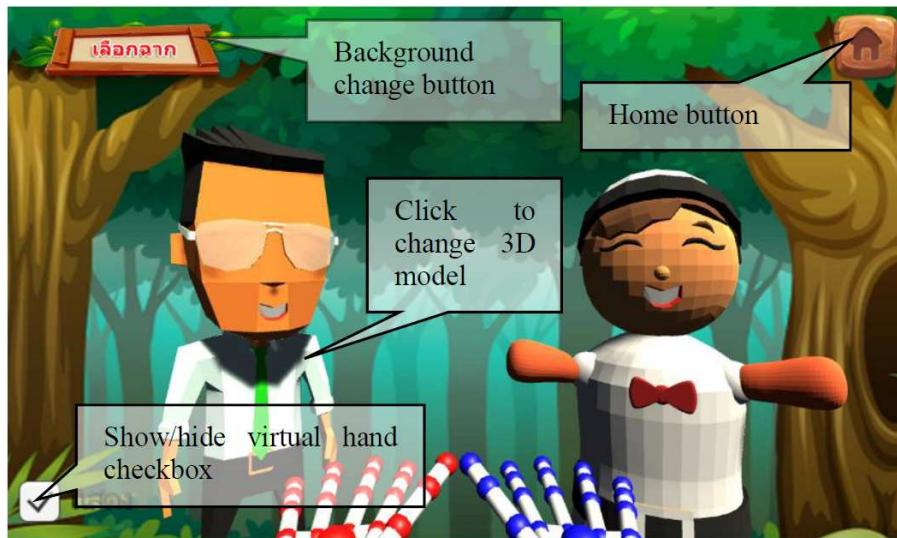


FIGURE 6. GUI of VPST application

virtual puppet model, 4) control virtual puppet for telling stories and 5) back to the home screen.

Therefore, the two research questions can be drawn as below.

- Are there the individual differences in learning achievement among students who learn by VPST and traditional storytelling?
- How do the students' perceptions differ when both groups have learned the three lessons using VPST and traditional storytelling?

4. **Results.** The research results are represented in connection to the research questions in Sections 4.1 and 4.2, respectively.

4.1. **Analysis of learning achievement results.** The purpose of the pre-test is to guarantee that all participants had the equivalent prior knowledge. Table 1 shows that pre-tests have insignificant difference ($t = 0.458$, $p = 0.650$) between the CG and EG. This implies that the CG and EG had the same prior knowledge.

TABLE 1. t -test analysis results

Variable	Group	n	M	SD	t	p
Pre-test	CG	19	3.684	1.565	0.458	0.650
	EG	17	3.470	1.179		
Lesson 1 score	CG	19	8.211	1.398	-1.265	0.214
	EG	17	8.824	1.510		
Lesson 2 score	CG	19	7.842	1.385	-5.155	0.0***
	EG	17	9.647	0.606		
Lesson 3 score	CG	19	7.421	1.575	-6.430	0.0***
	EG	17	9.824	0.393		
Overall score	CG	19	23.526	3.405	-5.236	0.0***
	EG	17	28.294	1.929		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

In addition, the t -test results demonstrate that the EG has significantly greater differences than the CG in lesson 2 ($t = -5.115$; $p = 0.000$), lesson 3 ($t = -6.430$; $p = 0.000$), and overall score ($t = -5.236$; $p = 0.000$), and the average scores of the EG for lesson 1 ($M = 8.824$, $SD = 1.510$) are greater than the CG ($M = 8.211$, $SD = 1.398$). The

main reasons why the EG students outperformed the other group are that the VPST can create stories that inform the student to recall the lesson contents [2] by helping with media (i.e., words and pictures) [3]. Also, VPST can increase classroom communications and encourage an appropriate classroom environment [8] to engage EG students to have more motivation to study and enjoy their class lessons, as concluded by the reports of [11,12].

To sum up, on the findings mentioned above, virtual puppet and digital storytelling of VPST are the critical tools for creating exciting and helpful learning activities to enhance students' learning outcomes.

4.2. Students' perceptions and interviews. The experimental and control group obtained as responses, they ranked questionnaires (i.e., technology acceptance model or TAM) [13] using a Likert scale to range from strongly agree (5) to strongly disagree (1). According to the *t*-test of each dimension, the ranking scores of the EG are significantly higher than the CG, as demonstrated in Table 2. This conclusion presents three educational issues. Firstly, the students of EG think VPST as easy to use for learning lessons,

TABLE 2. *t*-test results of the students' perception

Question	Group	<i>n</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>p</i>
Perceived ease of use	CG	19	4.500	0.553	-2.207	0.036*
	EG	17	4.824	0.303		
1) We think that these learning activities are convenient to our learning.	CG	19	4.895	0.315		
	EG	17	4.941	0.243		
2) We think that these learning activities are suitable communications in the classroom.	CG	19	4.526	0.964		
	EG	17	4.824	0.393		
3) We think that these learning activities assist us to get better learning activities.	CG	19	4.000	1.054		
	EG	17	4.824	0.393		
4) Overall, we think that these learning activities assist us to learn easily and joyfully in the classroom.	CG	19	4.158	0.958		
	EG	17	4.647	0.493		
Perceived usefulness	CG	19	4.395	0.679	-2.869	0.008**
	EG	17	4.882	0.281		
5) We think that these learning activities assist us to understand learning contents.	CG	19	4.368	0.831		
	EG	17	4.824	0.529		
6) We think that these learning activities are useful to our learning.	CG	19	4.316	1.003		
	EG	17	4.706	0.470		
7) We think that these learning activities assist us to get more attention in our learning.	CG	19	4.211	0.918		
	EG	17	4.647	0.996		
8) Overall, we think that these learning activities are more useful for our learning.	CG	19	4.158	1.119		
	EG	17	4.882	0.332		
Attitude toward using	CG	19	4.263	1.046	-2.927	0.009**
	EG	17	4.971	0.121		
9) We think that we prefer these learning activities for our learning.	CG	19	4.263	1.368		
	EG	17	4.882	0.332		
10) We think that these learning activities are very suitable learning style.	CG	19	4.105	1.100		
	EG	17	4.765	0.437		
11) We think that these learning activities can be applied to all our learning classes.	CG	19	4.053	1.353		
	EG	17	4.647	1.057		
12) Overall, we very prefer these learning activities for our learning.	CG	19	4.421	1.170		
	EG	17	5.000	0.000		

p* < 0.05; *p* < 0.01; ****p* < 0.001

and as a result, they enjoy the learning activities [9,14]. Secondly, the EG students perceive activities of VPST are useful for their learning activities. This indicates that VPST is a helpful tool for enhancing them to gain higher achievements [8]. Finally, the EG students accept VPST as a learning tool in their class; they claimed that they need to perform learning activities with VPST in every course they will accompany as similar to the summarization of physical puppet use that is proposed by [15].

Simultaneously, as the questionnaire responses, we interviewed both groups of students with open questions about the usefulness of VPST and QR-code cards. We concluded the interview as follows. Firstly, the experimental student number 1, 3, 4, 5, 6, 7, 8, 11, 12, 14, 17 mentioned that they could benefit from using VPST in the classroom; it makes them alert to learn in every moment. Secondly, almost EG students said that they enjoyed activities of VPST and wanted to make stories by themselves. Finally, almost all students in both groups enjoyed answering immediate post-test questions with QR-code cards that why they gave a high rating of perceived usefulness dimension (4.395 for the CG and 4.882 for the EG). This illustrates that the QR-code card is an attractive communication tool in the classroom.

5. Conclusions. First, the conclusion will start from a technical aspect. The virtual puppet storytelling application was developed as a learning tool that can make a variety of multimedia objects and create several of scenes or stories. VPST can be controlled by a hand gesture of the storyteller to the left and right puppets. Therefore, VPST is a useful educational tool and less expensive than traditional puppet which need to create physical puppets and decorate a puppet theater.

Second, the analysis results showed that the EG students were able to give more correct answers because VPST exposed their motivation to learn the lessons and created joyful activities in the classroom. In addition, the interview exposed that the students of EG accepted VPST as a learning tool and had high encouragement to apply VPST in their learning activities.

For the implication, this study suggests using VPST in the classroom because of the educator no need to prepare more thing, except Leap Motion and a big screen monitor. Moreover, VPST can make several learning stories or dramas for educational purpose.

In this study, there is one major limitation: this VPST application is the first version, and it does not have some key features such as slides on the same screen, subtitles, and sound. If soon it can be expanded with these new features, it can provide more useful learning activities to students.

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