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BUILDING A SELF-GENERATED DRAWING ENVIRONMENT TO IMPROVE CHILDREN'S PERFORMANCE IN WRITING AND STORYTELLING

CALVIN C. Y. LIAO

Graduate Institute of Network Learning Technology, National Central University, No. 300, Jhongda Road, Jhongli City, 32001, Taoyuan County, Taiwan, ROC.
Calvin@cl.ncu.edu.tw

YI-CHIAN LEE

Graduate Institute of Network Learning Technology, National Central University, No. 300, Jhongda Road, Jhongli City, 32001, Taoyuan County, Taiwan, ROC.
Peggy@cl.ncu.edu.tw

TAK-WAI CHAN

Graduate Institute of Network Learning Technology, National Central University, No. 300, Jhongda Road, Jhongli City, 32001, Taoyuan County, Taiwan, ROC.
Chan@cl.ncu.edu.tw

This study develops a self-generated drawing environment for the support of young children's writing and storytelling skill through the implementation of drawing, writing, and storytelling activities. In particular, each student used a tablet PC to share a story and drawings based on written text. An experiment was conducted in a primary school with 116 1st grade students from four classes (divided into two groups, EG: experimental group, n = 87; CG: control group, n = 29) and three teachers over the period of one semester in order to understand the influence of the activities on the students' writing and storytelling skills. Students participated in four rounds of experimental activity from drawing to writing and storytelling; each round consisted of a drawing, writing, and storytelling session. The findings indicated that 1) the length of the writing increased gradually; 2) the quantity (richness of vocabulary) and quality (story structure) of the storytelling of the students in the EG were significantly different and better than in the CG. Finally, some implications about the experimental results are also discussed.

Keywords: Self-generated drawings; writing; storytelling; language learning.

1. Introduction

In recent years, a number of studies have explored how student-generated drawings could facilitate diverse discipline learning (van Meter & Garner, 2005), in areas such as reading (Mason, Lowe, & Tornatora, 2013; Schwamborn, Mayer, Thillmann, Leopold, & Leutner, 2010), writing (Norris, Mokhtari, & Reichard, 1998), science (Ainsworth, 2010; Ainsworth, Prain, & Tytler, 2011; Leenaars, van Joolingen, & Bollen, 2013), and mathematics (de Bock, Verschaffel, & Janssens, 1998). In other words, diverse discipline learning activities benefit from the student's self-generated drawings and it is shown that

this strategy has potential value for strengthening the oral language and written language skills of primary school aged children (Norris et al., 1998; van Meter, 2001; van Meter & Garner, 2005; van Meter, Aleksic, Schwartz, & Garner, 2006). In short, the self-generated drawing strategy could play a key role in the transformation of students' writing and storytelling skills from the emergent to conventional phase. In the next section, some related studies are reviewed and the advantages and disadvantages of self-generated drawing for students' writing and storytelling are discussed.

1.1. *The relationship between drawing and writing*

Over the last three decades, the relationship between drawing and writing has been explored in relation to children's literacy development (Caldwell & Moore, 1991; Moore & Caldwell, 1993; Norris et al., 1998). Some studies have suggested that student-generated drawings can support a variety of language learning activities (van Meter & Garner, 2005). In particular, these suggestions include improving the understanding story grammar (Lesgold, Levin, Shimron, & Guttmann, 1975), improving comprehension of expository text (Paquette, Fello, & Jalongo, 2007; Rich & Blake, 1994), construction of knowledge representation (van Meter & Garner, 2005), preparation for narrative writing (Caldwell & Moore, 1991; Moore & Caldwell, 1993), and pre-writing strategy (Norris et al., 1998). The above related studies suggest that self-generated drawing should have the potential to assist in language learning. Thus, this study organized a relevant study. The findings show that it is possible that self-generated drawing could facilitate students' writing by enhancing their engagement in the process, providing more information, helping them to organize the relationship between ideas, and expressing complex meaning.

Ainsworth et al. (2011) mentioned that drawing is related to individual differences between students. A drawing is shaped by the students' current or emerging ideas and knowledge as well as their visual imagination. Students could write down their thoughts about drawings representing the main ideas of each paragraph in the text (Schwamborn et al., 2010). Hoffmann and Wittmann (2013) emphasized that students could organize both drawing and writing giving them the power to translate ideas, concepts and observations into specific, visual, and reproducible representations. Finally, students can utilize self-generated drawing to comprehend complex animation (Mason et al., 2013), meaning that drawing could be used to express complex meanings and supplement their writing about easily misunderstood and complex concepts. The aforementioned studies lead one to believe that the development of a self-generated drawing strategy related to students' writing could play a key role in language learning.

1.2. *The relationship between drawing and storytelling*

For a long time, oral narrative (i.e. storytelling) has been considered an important part of interpersonal interaction and social communication (Vygotsky, 1986). Some studies have argued that the creation of oral narratives about the child's drawing and writing could act as a scaffold for topical understanding, such as in the talking drawing strategy (Paquette

et al., 2007) and using drawings in planning and discussion (van Meter & Garner, 2005). In other words, the creation of oral narratives about their drawings and writing allows children to share more detailed and accurate information with each other; the children become acutely aware of the contrast between the pre-drawing-and-writing and the post-drawing-and-writing. In particular, children determine whether they should modify their original illustrations, create new drawings, or add new text that more accurately reflects their drawing and writing. Based on a review of relevant studies this study has found that self-generated drawing could support students' storytelling abilities by reminding them about the details of the story, reducing chances for misunderstanding, and promoting listening comprehension of the shared stories.

A recent study has found that students use drawing as a memory aid in verbal presentations (Madsen, 2013), making it easier for them to present and explain their products to the rest of the class. In other words, the drawing acts as a scaffold for the students' presentations, helping them to move from visual images to verbal language. Bollen, Gijlers, and van Joolingen (2012) argued that drawing, as a form of self-constructed external representation, should be beneficial to student learning in the context of peer interactions, such as during story sharing. The representation of drawing could help the students formulate less ambiguous mental models of phenomena and reduce the load on their working memory. Paquette et al. (2007) considered that the talking drawing strategy enables students to combine existing knowledge with new information and translate their newly-acquired understanding, including during storytelling with other students, to create a more detailed drawing. By talking about their drawings, students can increase their understanding and focus better on the task at hand, as well as promote listening comprehension during the sharing of stories. The aforementioned studies also lead one to believe that a self-generated drawing strategy developed for students' storytelling could play a key role in language learning.

However, there have been few empirical studies of the impact of drawing on storytelling and writing and its systematic implementation in formal schooling, thus, much remains unknown about this learning process. On the other hand, Ainsworth et al. (2011) noted that "*Students need to learn how scientists use multiple literacies of this subject to construct and record knowledge, where reading, writing, and talk are integrated with visual modes*". The above statement indicates that drawing can help students to practice manifold representations, such as writing and storytelling. Students can generate their own representations, which, according to specific conventions and purposes, can assist in deepening their understanding and thus facilitate their awareness from prior knowledge to processing new information (Bollen et al., 2012). Often however, children in Taiwan lack the opportunity to practice oral narration and express their opinions (Chang & Ku, 2008). Norris et al. (1998) noted that there has been limited formal study about the role of drawing in the writing process of children in primary grades 1-3. We argue that if we could combine drawing, writing, and storytelling it would have a meaningful impact on children's language learning.

This study attempts to show how the drawing, writing, and storytelling produced by the students improve the children's writing skills and storytelling abilities. Currently, the focus is specifically on answering the question: *How does the strategy of self-generated drawing impact children's language learning in terms of writing and storytelling?* To answer this question, a semester long experiment was conducted in the primary grades of an elementary school in Taiwan.

2. Self-generated Drawing Environment

The development of a self-generated drawing environment to support young children's writing and sharing of their products has been detailed in a previous study, entitled a **Drawing & Writing System** (Liao, Lee, Wu, & Chan, 2012; Liao & Chan, 2013). In this current study, we implemented drawing, writing, and storytelling activities using a digital drawing process to simplify the automatic sketching process, which could be used to support students in creating products from the drawings. Specifically, each student used a tablet PC to share a story with drawings made based on the written text. Our research team had previously conducted a pilot study in a kindergarten (Lee, Liao, & Chan, 2010; Lee, Liao, Wu, & Chan, 2011). In this pilot project, we found that the Drawing & Writing system could inspire the children's imagination and creativity, and strengthen their interest in writing in support of their storytelling. We then attempted to design a self-generated drawing environment suitable for students in kindergarten and elementary school. The former can use drawing to support their storytelling; the latter can add writing.

2.1. *The students' learning activity: Drawing, writing, and storytelling*

In this section we describe the use of the Drawing & Writing system in classroom learning activities. Students need to paint a picture and write a story for a particular topic. The learning activity includes three steps, as shown in Figure 1.

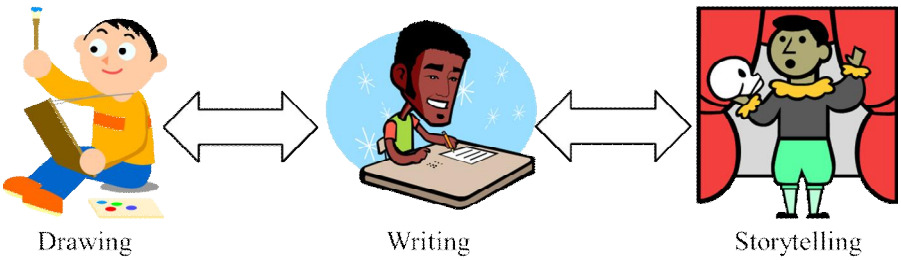

Figure 1. The students' learning activities in the Drawing & Writing system.

Table 1. The roles students played in the Drawing & Writing system.

	Students Roles	Descriptions
Drawing	Artist	Students need to think and organize their ideas, and then draw the pictures.
Writing	Writer	Students need to describe and explain these pictures, and then write down some material based on their ideas.
Storytelling	Performer	Students need to share and present this written material and pictures with others.

Step 1: students need to think and organize the ideas they have in mind, and then draw the relevant pictures. Step 2: students need to describe and explain these pictures, and then write down some script based on their ideas. Step 3: students need to share and present the written material and pictures with others.

For a summary of the roles the students played in the educational Drawing & Writing system please see Table 1.

2.2. *Drawing & Writing system*

The Drawing & Writing system provides a channel for writing. For example, students could write a story describing others' sketches. Through the system, they can share ideas and perhaps derive inspiration and ideas from others, rather than being limited to what they read or their own personal experience. The Drawing & Writing system utilizes three strategies to enhance students' learning and motivation. It is hoped that the system design is flexible enough to support various activities, whether in the classroom or after school. The Drawing & Writing system functions include: *drawing*, *writing*, and *storytelling*. First, students are encouraged to draw something related to a topic or concept from prior knowledge. Next, they are encouraged to label their drawings with words. Final, they are asked to share their product with others.

Drawing: The computer system provides the most basic functions, for example: brush, eraser, color, and so on; see Figure 2. The "eraser" tool can be used to easily wipe out unwanted drafts and the "undo" tool can quickly allow the student to return to the previous step. Paper cannot provide these functions. The buttons are designed to be intuitive to avoid cognitive overload. Students can sketch using these system functions and label their sketches. The system will also investigate the source of the ideas such as: (1) imagination, (2) their own experience, (3) reading experience, and (4) other. After the completion of the product, the students can choose whether to share their picture with others. The sketches could thus become a storytelling resource.

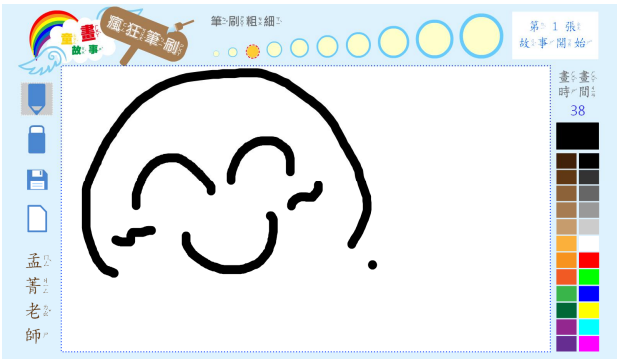

Figure 2. Students are asked to make a drawing related to a topic or concept based upon prior knowledge.

Writing: Students are asked to write a story related to their own sketches; see Figure 3. Students can use the keyboard to input words or handwrite on the screen. They have to input a story topic and the system will search for related words which can be used in the story writing. In this activity, the system provides video and sound recording functions. Students can also use these to tell a story based on their writing. After writing or telling the story, the students can choose whether to share it with others and publish in a portfolio.

Storytelling: The "portfolio" function collects the students' sketches and stories, and the students can review all their products; see Figure 4. With the touch of a button they can view others' creative writing efforts or speeches. Paper cannot record the sketching process, but this system provides this function. In the portfolio, students can see others' sketching process, and they can learn from each other. In addition, the system also provides a "recommend" feature, so that students can vote for their favorite creations. We hope that this system makes writing more fun and will help students with creative writing and speaking.

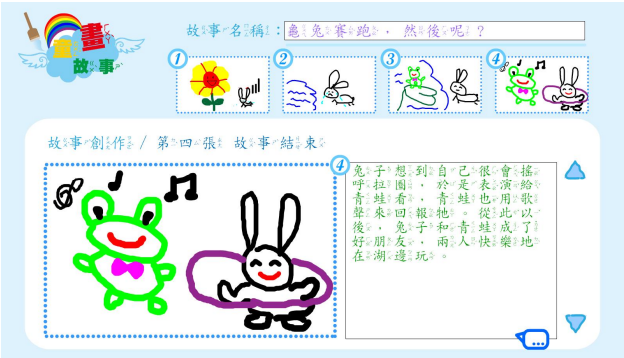

Figure 3. Students are encouraged to label their drawings with words.

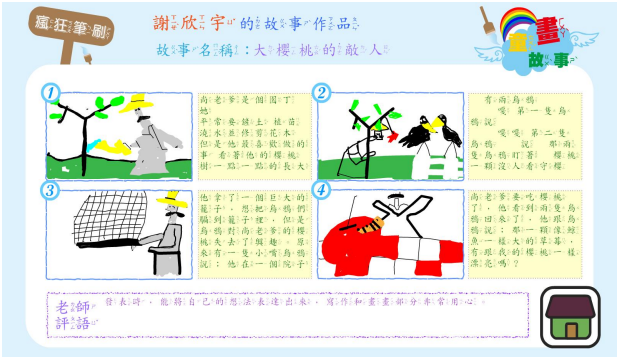

Figure 4. Students are encouraged to share their productions with others.

The Drawing & Writing system is designed to let students draw and have fun, while at the same time write a story about their sketch. In other words, students find an element of interest from the process of drawing and transfer their thoughts into writing, and present their products. There are two main sources of products: one is reading and the other is life experience.

3. Methods

3.1. *Participants and research design*

The current study employed a quasi-experimental design. The participants were 116 seven-year-old first-grade students (62 males and 54 females) from four classes at an elementary school in rural Taiwan and their three teachers. These students were assigned to one of two conditions: experimental group (EG, n = 87), or control group (CG, n = 29).

The EG students were asked to draw, write, and tell their stories using the Drawing & Writing system. The themes for the activities were provided: *after class time*, *favorite books, story relay, and family travel.* Each student was given a computing device with wireless capability, a "tablet PC". The digital classroom environment included a wireless access point and interactive whiteboard. In the previous semester, students had utilized the tablet PC for three months of Chinese typing training (using the Zhuyin input method) in a game-based typing environment called My-Pet-Typing (Liu, Liao, & Chan, 2013). This system applies a level-and-star-mechanism to adjust the level of difficulty in order to facilitate the typing skills of children. Students were asked to show imagination to create products based on these themes, telling many diverse stories using the interactive whiteboard in the classroom.

For comparison, students in CG were only offered conventional teaching instruction. The performance of CG is utilized as the baseline for evaluating the effectiveness of the Drawing & Writing system. In another study by Kulik, Kulik, and Cohen (1980), students in the experimental group received technology supported instruction, whereas students in

the control group received instruction by conventional teaching methods. The conventional teaching method has been espoused as providing an opportunity for students to learn directly from subject experts (teachers), but this method can lack flexibility, and does not always accommodate itself well to the diverse learning needs of students.

All students and teachers participated in the experiment for one semester.

3.2. *Instruments*

The oral narrative task was conducted in order to understand the students' narrative ability. The story book chosen was appropriate for children this age and had 24 pictures, but no words or colors from. The book was entitled "*Frog, Where are you?*" (Mayer, 1969). The story describes a boy and his dog looking for a frog. A picture story book was selected for the experimental material because it has been indicated in previous studies (e.g. Nikolajeva, 2003) that a wordless story could provide a more meaningful space for students to make up their own explanation; the lack of color was so that students could describe and express their own thoughts.

All students were tested individually. The oral narrative task conducted for this study contained two steps: 1) students were allowed 5 minutes to "read" the frog story in order to understand the content, and 2) students had to tell the story from the story book after 10 minutes. We, the researchers, played the role of the audience listening to the telling of the story. There was no time constraint for the students to complete this task, but most of them completed it in approximately 15 minutes. A digital video and audio recorder were used in a quiet room at the library.

3.3. *Procedure*

The experiments using the Drawing & Writing system were divided into three phases.

First phase: to familiarize students of EG with the use of the Drawing & Writing system. The students participated in three forty-minute training sessions: operating the system, understanding the story structure, and practicing the storytelling skills. This was done to avoid any influence or effect of unfamiliarity with the system and activity. A pretest of the oral narrative task was conducted in order to establish a baseline for storytelling ability. In addition, students of CG also participated in a pretest for the oral narrative task.

Second phase: the experimental activity was conducted in 12 forty-minute class sessions. Each EG student used a tablet PC to draw, write, and tell about their works created through using the Drawing & Writing system. Students participated in four rounds of experimental activity from drawing to typing and speaking; each round consisted of drawing, writing, and storytelling sessions.

Third phase: when the students of EG finished the experimental activity, it was followed by a posttest of oral narrative task. Similarly, students of CG also participated in the posttest for the oral narrative task.

3.4. *Data analysis*

3.4.1. *Chinese Latent Semantic Analysis*

Chinese Latent Semantic Analysis (CLSA) is a mathematical method that can model and simulate the meaning of words and passages by analysis of representative corpora of natural text to create a Chinese semantic space using a math vector database to create a word net. It was found in a previous study (Chen, Wang, & Ko, 2009) that two different sentences or documents can be estimated through the Chinese semantic relationship of calculation. A CLSA website (retrieved from http://www.lsa.url.tw/modules/lsa/) has been developed by Chen et al. (2009) at National Central University in Taiwan. The CLSA website was adopted to parse the students' transcripts from the pre/post oral narrative task for features such as *narrative length* and *richness of vocabulary*.

3.4.2. *Grammar analysis*

The students' narrative ability and grammar used in the story during the oral narrative task were measured. Story grammar analysis (SGA) was developed in this study based on the definition of story schema (Stein & Glenn, 1975), and a modification of the story grammar checklist (Wu, 2007). Stein and Glenn (1975) indicated the five main types of episodes to represent the story schemas: *major setting and minor setting, initiating an event, internal response, plan/attempt,* and *consequence*. These story schemas are described in detail below: major and minor setting (Max: 6 where Max is the maximal score for this story schema); introduction of the beginning of the story; description of the characters and the relationships between them (e.g. a boy, a dog, a frog); and the background setting of a story (e.g. in the room). Initiating event (Max: 4): a description of the whole incident (e.g. a frog disappears). Internal response (Max: 4): the character's affective reactions and cognitive thinking (e.g. a boy looks for a frog). Plan/attempt (Max: 26): the characters act in order to solve a problem (e.g. a boy turns his boots in order to seek the frog). Consequence (Max: 28): the outcomes of the actions taken (e.g. the boy did not find the frog).

SGA is adopted in this study for analysis of the students' transcripts form pre/post oral narrative tasks, such as *story grammar*, and *coherence*. Three experts with an educational background (including the authors) were asked to validate the scores for students' story grammar, based upon a table of specifications for SGA instruction. We consider that effective narration requires sufficient elaboration of the critical narrations. The internal consistencies of the pre/post oral narrative task were 0.95 and 0.91 (Cronbach's Alpha), respectively.

4. Findings

4.1. *The length of the writing*

This study collected 348 products of student efforts during the four rounds of activities. The topics were *after class time*, *favorite books*, *story relay*, and *family travel*; see Table 2. All students' products generated from drawing to writing and speaking in Drawing & Writing system. Students active shared and presented their products which were publically reviewed in class.

The length of writing increased gradually between product 1 and product 4. In particular, the average length of writing was for product 1 (M = 46.08, SD = 18.52), product 2 (M = 66.51, SD = 49.56), product 3 (M = 70.21, SD = 45.10), and product 4 (M = 72.33, SD = 44.20). Moreover, the paired-sample t-test was conducted to examine whether the length of writing had significantly improved. The results revealed a statistically significant difference in length between product 1 and product 4 (t = 5.68, $p < 0.001$). This means that all students participating in the Drawing & Writing system had improved the length of their written product. The length of individual student's product was different. In particular, the distribution of length of writing was as follows: class A (from 45.95 to 98.96), class B (from 46.85 to 65.14), and class C (from 45.43 to 52.88). The results showed a gradual increase in the length of writing. Based on classroom observations and system records, we conjecture three possible reasons: 1) student's type at different rates; 2) the teacher's participation in story making and demonstration forms; 3) the teacher's comments given to students' productions. Because of limitations of space and time, partial results for writing, excluding the quality of the writing are presented.

4.2. *The narrative ability of storytelling*

In order to understand how to improve students' narrative ability during storytelling, we need to conduct further examination with CLSA and SGA to uncover the difference in narrative ability between EG and CG. Narrative ability consisted of the quantity of storytelling, and the quality of storytelling. The quantity of storytelling included *narrative length* and *richness of vocabulary*. The former indicates the spoken words in

Table 2. Means (M) and standard deviations (SD) for the length of writing (n = 87).

	Product 1: After class time	Product 2: Favorite books	Product 3: Story relay	Product 4: Family travel
	M (SD)	M (SD)	M (SD)	M (SD)
A (n = 29)	45.96 (17.59)	72.80 (32.20)	86.49 (39.37)	98.96 (49.13)
B (n = 29)	46.85 (17.26)	69.81 (70.11)	66.87 (46.86)	65.14 (42.23)
C (n = 29)	45.43 (21.04)	56.92 (32.89)	57.27 (30.64)	52.88 (22.65)
Average	46.08 (18.52)	66.51 (49.56)	70.21 (43.10)	72.33 (44.20)

the oral narrative task while the latter indicates the students' spoken vocabulary (excluding duplicate vocabulary) in the oral narrative task. The quality of storytelling focused on *story grammar*. Story grammars indicate the students' spoken grammars in oral narrative task. Story grammars were composed of setting, initiating the event, internal response, attempt, and consequence.

4.2.1. *The quantity of storytelling: Narrative length and richness of vocabulary*

The results show narrative length for EG (M = 353.43, SD = 138.86) and CG (M = 382.17, SD = 126.33), while the post-test narrative length in EG (M = 391.09, SD = 136.62) and CG (M = 396.03, SD = 189.73). The results indicate an EG increase of 36.66 spoken words and a CG increase of 13.86 spoken words.

In order to understand the statistical significance of degree of increase of narrative length, we further compared EG with CG. The correlation coefficient between the pretest scores (covariate) for narrative length and posttest scores for narrative length was significantly high. A one-way ANCOVA was conducted on the narrative length scores and the results showed no significant difference in the treatments: $F_{(1,\ 114)} = 0.04$, $MSE = 527.75$, $p = 0.84 > 0.05$, partial $\eta^2 = 0.001$. There was no significant difference for narrative length (EG (M = 391.09, SD = 136.62) and CG (M = 396.03, SD = 189.73)).

Table 3 shows the pre-test richness of vocabulary for EG (M = 53.63, SD = 13.30) and CG (M = 53.45, SD = 12.85) and presents the post-test richness of vocabulary for EG (M = 59.70, SD = 14.76) and CG (M = 57.59, SD = 18.45). The results indicate increase for EG of 6.07 spoken vocabulary items and increase of 4.14 spoken vocabulary items for CG.

In order to understand the statistical significance of the increase in the degree of richness of the vocabulary, we further compared EG with CG. The correlation coefficient between the pretest scores (covariate) for richness of vocabulary and posttest scores for richness of vocabulary was significantly high. The one-way ANCOVA conducted on the richness of vocabulary scores revealed a significant difference between the treatments, $F_{(1,\ 114)} = 5.57$, $MSE = 871.80$, $p = 0.02 < 0.05$, partial $\eta^2 = 0.048$. The pairwise

Table 3. Means and standard deviations for the quantity of storytelling (n = 116).

	The Quantity of Storytelling			
	Narrative Length		Richness of Vocabulary	
	Pre-Test	Post-Test	Pre-Test	Post-Test
	M (SD)	M (SD)	M (SD)	M (SD)
CG (n = 29)	382.17 (126.33)	396.03 (189.73)	53.45 (12.85)	57.59 (18.45)
EG (n = 87)	353.43 (138.86)	391.09 (136.62)	53.63 (13.30)	59.70 (14.76)
A (n = 29)	316.14 (110.56)	361.50 (104.91)	48.79 (12.80)	57.86 (12.46)
B (n = 29)	387.03 (144.36)	425.36 (163.80)	55.41 (12.17)	63.11 (17.24)
C (n = 29)	357.10 (146.91)	386.59 (124.62)	56.69 (13.31)	58.21 (13.30)

Table 4. Means and standard deviations for the quality of storytelling (n = 116).

	Story Structure	
	Pre-Test	Post-Test
	M (SD)	M (SD)
CG (n = 29)	37.24 (10.26)	38.33 (10.55)
EG (n = 87)	32.08 (9.05)	39.59 (8.30)
A (n = 29)	30.66 (7.86)	39.93 (6.37)
B (n = 29)	36.74 (8.24)	41.43 (8.74)
C (n = 29)	28.79 (8.84)	37.48 (8.87)

comparison procedure revealed that students in EG (M = 59.70, SD = 14.76) showed a greater richness of vocabulary than those in CG (M = 57.59, SD = 18.45).

4.2.2. *The quality of storytelling: Story grammar*

Table 4 shows the pre-test grammar results for EG (M = 32.08, SD = 9.05) and CG (M = 37.24, SD = 10.26), and the post-test grammar results for EG (M = 39.59, SD = 8.30) and CG (M = 38.33, SD = 10.55). The results indicate an increase in EG of 7.51 spoken grammar items and an increase in CG of 1.09 spoken grammar items. In order to understand the statistical significance of increased degree at story grammars, we further compared EG with CG.

The correlation coefficient between pretest grammar scores (covariate) and posttest scores was significantly high. The one-way ANCOVA conducted on story grammar scores revealed a significant difference for the treatments, $F_{(1, 114)} = 8.43$, $MSE = 358.93$, $p = 0.00 < 0.001$, partial $\eta^2 = 0.072$. The pairwise comparison procedures revealed that students in EG (M = 39.59, SD = 8.30) showed a higher number of story grammar items than those in CG (M =38.33, SD = 10.55).

5. Discussions

5.1. *Improving writing and storytelling in children from the emergent to conventional phase*

In this study, we evaluated the contribution to the child's literacy (from the emergent to conventional phase) made by implementing the creative and productive activities related to drawing, writing, and storytelling experiences. We looked specifically at two improvements: writing and storytelling, where children were allowed to explore and create a digital product on their own, versus through peer interaction. Students functioning at higher developmental levels are capable of sharing even more vocabulary terms in their storytelling. A meaningful activity such as drawing, writing, and storytelling enables children to put into practice these skills, moving from the emergent to the conventional phase. In particular, children can learn to apply practical knowledge

representation to construct a unique story. More sophisticated children also utilize literacy knowledge, such as naming a title, arranging the storyline, and presenting the story, into their products gradually (John, Lui, & Tannock, 2003). This phenomenon proves that the Drawing & Writing system may promote these primary children's drawing, writing, and storytelling experiences form the emergent to the conventional phase.

5.2. *Supporting multiple representations from drawings to writing and storytelling*

Writing skills and oral narrative ability are not separate. When writing becomes work, students will gradually come to dislike writing and feel pain. This study tries to combine self-generated drawings, writing, and storytelling activities in the design of a Drawing & Writing system to assist children's story creation, to provide a stress-free space for the process, and to let students show their creative story-writing abilities. The purpose of this self-generated drawing strategy is to improve student writing and to let them take the initiative in writing. In particular, students used multiple representations to convey their ideas, including a series of creation, modification, and representation activities, such drawing the picture, writing a description, and telling the story. The students' favorites, thoughts, and experiences were presented.

Ainsworth (2006) indicated that multiple representations can provide unique benefits when students are learning complex new ideas, even help the students to actively construct their multiple representations (Cox, 1999). Students learn to construct, apply, and switch their own ideas between multiple perspectives. Moreover, Cox (1999) also indicated that multiple representations can enhance students' externalized cognition. The three processes of multiple representations can enhance students' drawing, writing, and storytelling capability. In the processes of drawing and writing, we provide two scaffolds: *story paragraphs* and *story elements*. The former was comprised of the introduction, elucidation, transition, and conclusion; the latter consisted of the main characters, locale, time, what the main characters wanted to do, what the main characters did, how the main characters felt, and how it all ended. Several examples of four story paragraphs and the seven story elements were given. In the process of storytelling, students can free themselves to demonstrate the pictures and text for any product simultaneously. They can share these pictures and written texts with others according to their willingness showing the visual, verbal, and written representations of their understanding.

6. Conclusions and Future Directions

This study developed a self-generated drawing environment to support young children's writing and storytelling. We implemented a drawing, writing, and storytelling activity. The findings showed 1) a gradual increase in the length of the writing; 2) there was a significant difference in the quantity (richness of vocabulary) and quality (story structure) of student storytelling between EG and CG.

6.1. *Future directions*

There are three future directions for implementing the *creation*, *sharing*, and *assessment* of story making. First, we should focus on story creation in order to increase the content and structure of the story, for example, material scaffolding to provide basic geometry and color selection; structural scaffolding, to provide scaffolding for story structure and to increase the number of story writing processes, such as with concept mapping (Liu, Chen, Shih, Huang, & Liu, 2011). Secord, we should focus on story sharing in order to provide opportunities for student interaction, such as through voice and video recording, to show and share their work, as well as voting and recommendations to provide peer-reviews and recommendations (Nicolaidou, 2013). Finally, we should focus on story assessment in order to enhance sentence usage and article structure, such as the correction of typographical errors, to assist teachers to correct typos and sentences as well as comment support to assist teachers to give suggestions according to the article structure (Kulik & Kulik, 1988).

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