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INTERACTIVE TECHNOLOGY FOR CREATIVITY IN EARLY CHILDHOOD EDUCATION

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Graphical abstract

Abstract

Although Information and Communication Technology (ICT) is dramatically expanding in Taiwan, its educational implications are lacking in early childhood education. The purpose of this study is to apply ICT in developing digital learning materials to enhance young children's creativity. To achieve this goal, the study incorporated a focus group, observations and experimental research. The researchers designed nine sets of interactive devices using an interactive desktop, Kinect and iPad. Through an intentional sampling method, four kindergarten classes, consisting of 149 children aged 4-6, were involved in the study, with gender, public/private and city/suburban factors taken into consideration. Findings showed that the experimental group's flexibility and originality was significantly better than those in the control group. These findings demonstrated that the interactive devices designed by the study were effective in enhancing the children's creativity. The findings also revealed that: suburban children are significantly more fluent than city children, boys possessed significantly more originality than girls, and private kindergarten children were significantly more fluent and flexible than those from the public schools.

Keywords: Interactive tehnology, creativity, early childhood education

1.0 INTRODUCTION

While children are creative, their creative growth is likely to be limited when they grow older. As Taiwan becomes more developed, the government should advocate the importance of creativity. However, its current educational curriculum for preschools places greater emphasis on children's moral education and physical fitness, rather than developing their creativity. To date, Taiwanese research on children's creativity has been restricted to traditional methodology. For example, the principles of curriculum design for creativity training include the following aspects: questioning, thinking, practicing and evaluating. But what kind of educational tools can help boost young children's creativity? This study, by using interactive technology to support the school curriculum, examines whether or not integrating technology and teaching can lead to developing creativity.

In Taiwan, few schools use ICT (Information and Communication Technology) as a tool for teaching and learning. One of the main reasons is that the teachers generally lack the knowledge and skills regarding such integration. Moreover, the application of ICT in preschool education is overlooked in the National Curriculum Plan, which in turn limits the development of interactive technology and its use in education. Therefore, this study also aims to discuss the extent to which ICT can be integrated and fully developed into Taiwan's preschool teaching.

There are two opposing arguments regarding the relationship between the use of technology and creativity [1]. On the one hand, it is argued that creativity is an innate ability that cannot be developed through learning; on the other hand, it is argued that the advancement of technology has resulted from the development of creativity. In turn, technology can stimulate the development of

creativity, fulfill one's potential, and lead to innovation.

One of the characteristics and advantages of using interactive technology in education is that it often draws the children's attention and arouses their interest in learning. By interacting with teaching materials, children consider various ways in which they can complete an assignment or project. This is a reflection of the development process of cognitive ability, where one comprehends, discusses, internalizes and acts. Several childhood studies have demonstrated that creative educational games can lead to better creative performance. Also, with the help of technology, it takes less time to complete creative works, and each is unique [2, 3, 4, 5, 6, 7].

Creativity is operationally defined in this paper in terms of fluency, flexibility, and originality selected from the Torrance Test of Creative Thinking and the Creativity Test for Preschoolers [8]. It is shown that three dimensions of creativity (originality, fluency and flexibility) constitute a framework within which creativity can be defined and measured [9]. A preschooler's fluency can be assessed by the amount of ideas. Flexibility can be measured by the amount of categories of ideas. Originality can be scored by the amount of unique thoughts different from the others.

2.0 PROBLEM STATEMENTS

This study aims to examine whether the integration of interactive technology into teaching can enhance creativity in young children. The creativity test predictors include fluency, flexibility and originality. The significance of this study lies in providing empirical evidence for using interactive technology to facilitate creative development. This study will investigate the following six questions:

- What is the mean creative difference between the experimental groups' pre-test and post-test scores?
- What is the mean creative difference in the pre-test scores between the experimental and control group?
- What is the mean creative difference in the post-test scores between the experimental and control group?
- What is the mean creative difference in the experimental groups' post-test scores between children from the city and those from suburban areas?
- What is the mean creative difference in the post-test scores between boys and girls in the experimental groups?
- What is the mean creative difference in the post-test scores between public and private school children in the experimental groups?

3.0 METHOD

The study adopted an experimental research method and conducted teaching experiments aimed at using interactive technology to facilitate creativity. The sample included five classes of 149 preschoolers, aged 4 to 6, who were attending four schools (both public and private) located in Taipei City and New Taipei City. The researchers designed nine different teaching materials, such as a Smart Table, to be used in experiments over a period of nine weeks. The device used for the pre-test and post-test measurements was based on a revised version of the Torrance Test of Creative Thinking and the Creativity Test for Preschoolers [8]. The device used for formative assessments was based on the nine different worksheets designed by the teachers who participated in the research. They also designed nine different lesson plans where all nine teaching materials were used. Each teaching session lasted 40 minutes and was held weekly between April and July 2011. The Creativity Test for Preschoolers was conducted at the beginning and end of the teaching sessions.

3.1 Pre-Test and Post-Test Design

The model for the study's pre-test and post-test design is as follows:

R O_1 X O_2 (the experimental groups)
R O_3 O_4 (the control groups)

Four procedures were adopted:

- The use of random sampling and random distribution in both groups.
- The same pre-test was given to both groups before the experimental intervention.
- The intervention was given only to the experimental groups.
- The same post-test was given to both groups after the intervention.

3.2 Child-Computer Interface Design

The content of the interactive games and activities was designed in accordance with the children's responses to their teachers' questions, as well as suggestions proposed by the teachers, programme designers and students. Once the project was completed, a pilot study was conducted with a group of preschoolers. The project was then revised based on suggestions made by the participants and experts, in order to complete the child-computer interaction's interface design for the study.

4.0 RESULTS

4.1 Difference between the Experimental Groups' Pre-Test and Post-Test Scores

A paired-sample T test was conducted to examine whether there was a significant difference between the experimental group's pre-test and post-test scores. The results are shown in Table 1.

Table 1 The creative difference between the pre test and the post test score for the experimental group

Creativity indicator	Pairs				
	Pre-test scores and Post-test scores				
	Mean	SD	t	df	*p*values
Fluency	-.288	2.158	-1.026	58	.309
Flexibility	-.847	2.172	-2.997	58	.004**
Originality	.593	1.922	2.371	58	.021*

*P<. 05, **P<. 01

Table 1 shows that there was a significant difference between the pre-test and post-test scores in terms of flexibility and originality, implying that the experimental intervention is valid. In other words, by integrating the interactive technology and teaching, the preschoolers' flexibility and originality can be significantly enhanced.

In this study, the interface design for child-computer interaction is in accordance with the curriculum design principles for creativity training, including the following aspects: questioning, thinking, practicing and evaluating, i.e. the teacher first guides the children through brainstorming some questions. The children are then asked to perform and conduct experiments. As new questions arise from the activity, the children can think more carefully about some of the ideas. Finally, by sharing their own findings, the children are able to combine their new skills and thoughts. However, in practice, there is, in general, a lack of teaching materials for the children to learn independently. In order to solve this problem, the study used interactive technology as a means of supporting the school's curriculum (as shown in Figure 1, 2, 3 and 4), as it takes less time to produce the teaching materials, and enables effective creativity training. Hence, two aspects were considered when designing the child-computer interface: one is concerned with the customization of interfaces to create an interactive learning environment for children, and the other is to enhance creativity through interactive games and activities. Technological designs and applications can be an extension for developing the mind, actions and creativity, but only after carefully considering pertinent issues for interface customization [10].

Figure 1 Cooperative play with Kinect and iPad

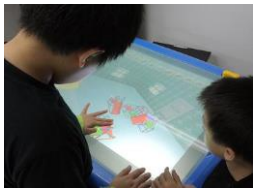

Figure 2 Interactive desktop play

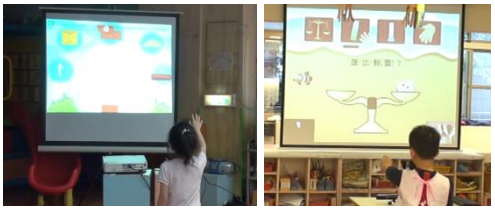

Figure 3 Wall projection with Kinect play

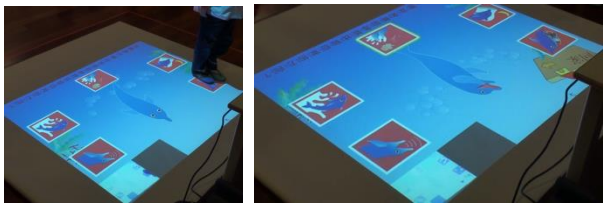

Figure 4 Floor projection with Kinect play

Figure 1 shows an example of integrating an interactive device into cooperative play. Here 2 children use an iPad to create graphics for problem solving. The server then transmits the graphic to the screen. Two other children use Kinect to capture the hot air balloon graphic and move it into the right place in the game. Once the problem is solved, the balloon flies into the sky.

In Figure 2, the child learns by using the interactive desktop. The teacher adopts a scaffolding inquiry technique to encourage the child to explore the logic behind the cause-effect relationship.

Figure 3 and 4 show two examples of how to use child-computer interfaces for interactive games and activities. A pilot study was conducted to design the interactive device in accordance with the children's responses and suggestions.

4.2 The Difference between the Experimental and Control Groups' Pre-Test Scores

An independent-sample T test was conducted to examine whether or not there was a significant difference between the experimental and control group's pre-test scores. The results are shown in Tables 2 and 3.

Table 2 Mean and SD of both group's pre test creativity scores

Creativity Indicator	Pretest			
	Experimental		Control	
	Mean	SD	Mean	SD
Fluency	7.68	2.029	7.9	2.203
Flexibility	5.25	1.738	5.15	2.504
Originality	2.29	1.702	2.83	2.335
Creativity	17.88	5.193	19.44	6.262

Table 2 shows the mean and standard deviation of the pre-test scores for both the experimental and control group, including the overall creativity scores and the creativity indicator's three scores.

Table 3 Difference in the pre test creativity scores between the two groups

Creativity Indicator	Pairs		
	Experimental-Control		
	t	df	p values
Fluency	-.565	116	.573
Flexibility	.256	116	.798
Originality	-1.442	116	.152
Creativity	-1.472	116	.144

As Table 3 shows, there was no significant difference in the pre-test creativity scores between the two groups, which suggests that the difference in their post-test creativity scores is the result of the experimental intervention.

4.3 Difference in Post-Test Scores Between the Experimental and Control Groups

An independent-sample T test was conducted, to examine whether or not there was a significant difference in the post-test scores for children in the two groups. The results are shown in Tables 4 and 5.

Table 4 Mean and SD of the post test creativity scores for both

Creativity Indicator	Posttest			
	Control		Experimental	
	Mean	SD	Mean	SD
Fluency	7.97	2.084	9.00	.000
Flexibility	5.85	2.132	5.93	1.684
Originality	1.69	1.684	2.71	1.782
Creativity	18.20	5.889	22.20	2.558

Table 4 shows the mean and standard deviation of post-test scores for both groups, including their overall creativity scores, and the creativity indicator's three scores. These results show that the post-test scores of children in the experimental group were higher than those in the control group.

Table 5 Difference in post test creativity scores between the two

Creativity Indicator	Pairs		
	Exp-Control		
	t	df	p values
Fluency	3.810	116	.000***
Flexibility	.238	116	.812
Originality	3.186	116	.002**
Creativity	4.785	116	.000***

***p<.01, *** p<.001*

As Table 5 demonstrates, there is a significant difference in the post-test creativity scores between the two groups in terms of fluency, originality and overall creativity. The results indicate that the use of interactive teaching materials enhances creativity for preschoolers, which is consistent with the results advanced by several previous studies [2, 3, 4, 5, 6, 7].

4.4 Difference in the Experimental Groups' Post-Test Scores between City and Suburban Children

A one-sample T test was conducted to explore the difference in post-test creativity between children, in the experimental group, who came from either the city or suburban areas. The creativity indicator's three scores were tested. The results are shown in Tables 6 and 7.

Table 6 Mean and SD of post test scores for the creativity indicator between city and suburban children

Creativity Indicator	Posttest			
	City		Suburb	
	Mean	SD	Mean	SD
Fluency	8.21	1.887	9.00	.000
Flexibility	5.97	1.831	5.80	1.700
Originality	2.29	2.035	2.80	1.901

Table 6 shows the mean and standard deviation for post-test scores of the city and suburban children, in terms of fluency, flexibility and originality. It suggests that the suburban children's fluency and originality scores are higher than those from the city.

Table 7 Differences in the creativity indicator between the city and suburban children's post test scores

Creativity Indicator	Pairs		
	City-Suburb		
	t	df	p values
Fluency	-3.207	147	.002**
Flexibility	.568	146	.571
Originality	-1.528	147	.129

*** p<.01*

Table 7 shows that children from suburban areas have significantly higher post-test fluency scores than those from the city. The other study argued that children from suburban and rural areas tend to demonstrate greater creativity than city children [12], possibly because they enjoy greater freedom and fewer restrictions. Also, city schools tend to apply more pressure on their students, which may limit the development of young children's creativity.

4.5 Difference between Boys and Girls in the Experimental Groups' Post-Test Scores

A one-sample T test was conducted to explore the difference in post-test creativity between boys and girls in the experimental groups. The creativity indicator's three scores were tested. The results are shown in Tables 8 and 9.

Table 8 The creativity indicator's mean and SD of post test score for boys and girls

Creativity Indicator	Post-test			
	Boys		Girls	
	Mean	SD	Mean	SD
Fluency	8.46	1.678	8.58	1.351
Flexibility	6.11	1.827	5.70	1.713
Originality	2.83	2.123	2.17	1.817

Table 8 indicates the mean and standard deviation of post-test scores from boys and girls in the experimental groups, in terms of fluency, flexibility and originality. It shows that boys display greater flexibility and originality, whereas girls exhibit greater fluency.

Table 9 Differences in the creativity indicator's post test scores between boys and girls

Creativity Indicator	Pairs		
	Boy-Girl		
	t	df	*p* values
Fluency	-.507	147	.613
Flexibility	1.422	146	.157
Originality	2.057	147	.041*

** p<.05*

As Table 9 indicates, although the post-test originality scores are significantly higher for the boys, there is no significant difference in post-test fluency and flexibility. Since parents and teachers tend to show greater appreciation to boys when they exhibit originality [12], such reinforcement can contribute to their different behavioral patterns. Related study argued that gender identity can be developed through observing and learning from the social environment [13]. For example, girls may learn to be obedient, and boys may learn to show originality.

4.6 Differences in the Experimental Group's Post-Test Scores for Public and Private School Children

A one-sample T test was conducted to explore the experimental groups' post-test creativity differences between children in public and private schools. The creativity indicator's three scores were tested. The results are shown in Tables 10 and 11.

Table 10 The Mean and SD of the creativity indicator's post test scores for public and private schools

Creativity Indicator	Posttest			
	Public		Private	
	Mean	SD	Mean	SD
Fluency	7.96	2.132	8.86	0.815
Flexibility	5.33	1.856	6.24	1.644
Originality	2.55	2.080	2.45	1.948

Table 10 indicates the mean and standard deviation of post-test scores for children from public and private schools, in terms of fluency, flexibility and originality. It shows that the post-test fluency and flexibility scores are higher for children in private schools than those in public schools.

Table 11 The creativity indicator's different post test scores for public and private schools

Creativity Indicator	Pairs		
	Public-Private		
	t	df	*p* values
Fluency	-3.641	147	.000***
Flexibility	-3.097	146	.002**
Originality	0.302	147	.763

*** p<.01, *** p<.001*

As Table 11 indicates, there is a significant difference in both fluency and flexibility between children from private schools and those in public schools. One of the main factors behind this result is that children in private schools are generally from a higher socio-economic background. It is therefore easier for them to acquire interactive devices, such as an iPad or Xbox, for learning and practicing. The related research also indicates that since private schools are more selective [14], they tend to provide a more creative curriculum, and their pupils tend to have a better academic achievement than the public schools.

5.0 CONCLUSIONS

In conclusion, this study has successfully applied technology in the design and production of ICT educational materials, which in large part, contribute to the advancement of creative teaching methods. The study has also inspired interdisciplinary research in areas such as: preschool education, design and technology, as well as contributing to the business development of interactive educational devices.

Additionally, the interactive devices developed by this study can improve children's learning motivation, develop their creativity and help preschool teachers produce more effective teaching tools. The study also found that the children in the experimental groups demonstrated significantly greater creativity (including flexibility and originality) than children did from the control group. Some significant relationships were also found between creativity and gender, school location and the nature of the school's regulations. For example, it was shown that boys display more originality than girls do; children in suburban areas demonstrate greater fluency than those in the city do; and children from private kindergartens show greater fluency and flexibility than those in public kindergartens. Further research will be done to develop a wider variety of interactive educational tools, and to examine how the use of different interactive devices can impact children's learning.

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