

# The Learning Effectiveness of Blended and Embodied Interactive Video Game on Kindergarten Students

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**Abstract.** We developed an embodied interactive video game (EIVG) that is both educational and entertaining in the hope of using such system to explore the differences that exist in learning effectiveness between blended and pure digital learning. Apart from conducting experiments by having the children learned using the EIVG, we also involved teachers as part of the study helping us observe the emotional aspect of the children. The results of the study can be summarized into the following: 1 The effectiveness of blended learning is much better comparing to that of pure digital learning. 2 The effectiveness of EIVG learning of boys is better than girls. However there is no significant difference between them. 3 The EIVG is highly entertaining which results in learning objects remain highly interested and focused throughout the study. Both types of learning can effectively improve the learning outcomes of the objects.

**Keywords:** blended learning, embodied interactive video game, game-based learning

## 1 Introduction

There is plenty of movement-based video interactive technologies exist in the current market such as Dance Dance Revolution, Xavis, Nintendo Wii, etc. The utilization of such technology can effectively motivate the users. Nevertheless, due to the expensive nature of such equipments, it is rarely seen in a typical school environment. What has become its feasible alternative is a computer equipped with a webcam that can be utilized as video interactive environment in a school network, based on which the development of video interactive learning can be realized [1].

Our research group has developed a web-based interactive video educational game system utilizing webcams, image recognition, networking technologies, with which a learner can input information using gestures and body movements. The learning history of a particular learner is to be recorded on a server, which can then be retrieved for the purpose of analysis and diagnoses. Our study also used this system to develop the interactive video learning materials for kindergarten children and at the same time conducted various experiments on kindergarten children.

## **2 Theoretical framework**

There have been many interpretations to the meaning of blended learning due to the evolution of its terminology [2]. Many researchers hold that blended learning should be a learning method that incorporates several instructional modes; or several instructional methods; or that of several educational environments such as that of online and face-to-face instruction. The most common interpretation is that of online as in e-learning and face-to-face activities [3].

Many researchers [2], after comparing the students involved in blended learning, hold that the relationship between the cognitive state of a student and his/her community awareness can serve as good indicators for the design of blended learning environment. Blended learning could increase the learning outcomes of a student and enhance his/her sense of community.

Piaget believes that human minds can be illuminated while involved in game playing [4]. It effectively stimulates intellectual activities and induces the application of reasoning, logic and various intellectual faculties of the brain. There have been many studies in the past that confirmed the great importance of game playing to the learning ability of children, especially to various aspects of a child such as his/her cognitive, social, psychological, physiological and ethical development.

Squire believes that through the repetitive practice of game playing, a learner can learn to master certain obtainable techniques, which then gives the learner a sense of instant reward thereby further motivates the learner and at the same time save work and time from the instructors. The EIVG learning software developed by our research lab possesses both the strengths described above; namely repetitive practice and instant reward.

Interaction video learning realizes a new form of visual education. It enables the learners to observe physical and realistic images of the learning subjects using their sight and touch. The learning outcome engendered by this form of learning is similar to that of face-face education [5]. This characteristic can be applied to any learning locations, effectively and synchronously enhance the learning results of students and at the same time improves the memory, understanding, application and responsiveness of each individual [1]. Therefore it enables students to obtain a better processing ability on the given learning content [6]. A student, by playing games, obtains an understanding of the meaning of an object or the ability to make rational judgments on the basis of the relationship between learning content and learning objects [7].

## **3 Method**

### **3.1 Research questions**

The research questions proposed by this study include:

1. Which of the two learning methods, blended learning or pure digital interactive video learning, gives better learning results?

2. Could gender and age differences contribute to the difference in learning outcomes in the case of blended learning?
3. Is there a difference in the learning trend of a child who has repetitively learned using the interactive video learning system?

### 3.2 Participants

The participants consisted of 255 kindergarten children, out of which 144 were male and 111 were female. All of them were aged between 4 and 5 and enrolled at local kindergartens in Taipei. There were 4 kindergartens selected, one per three administrative areas and 12 areas in total. Out of each selected kindergarten, two classes were selected making the total of 8 classes of kindergarten children.

### 3.3 Instruments

The primary research tool we developed was named Embodied Interactive Video Game (EIVG) shown as Fig.1. EIVG is a web-based digital learning system. The mode of interaction can be described thus: A kindergarten child is to face a computer monitor (or projector screen) equipped with a webcam observing the participants and questions appeared in the monitor. At anytime, there will be a few objects falling down from above and the player will pick a matching object using body movements, based on the question appeared on the top left hand corner. Every time when the game is over, the system will halt and announce the score gained by the player therefore the player can instantly see his personal score. There will also be encouraging words displayed at the end of the game play to motivate the player for self-challenge.



Physical games



Digital games

**Fig. 1.** The Instrument and the process of experiment

There is also a physical type of game play. It has the exact same rules as EIVG except that it requires the image files of various items found in EIVG to be printed out, which then can be used as learning material. The physical game play has the same timing and scoring system as that of EIVG.

The learning material of the game was organized and designed by kindergarten child experts and kindergarten teachers. The experiment includes two major categories each contains two game play modules. The first category contains the same game play module but different learning topics (Mode A) while the second category contains the same learning topic but different game play modules (Mode B). During

the learning phase, the system can record the learning history of each child. The data obtained can then be used for analysis.

### **3.4 Experimental design and implementation**

Among the kindergartens, two classes were selected from each kindergarten for experiment. One class would undergo pure digital learning while the other would undergo blended learning. For each blended learning class, a child would go through IVEG three times and its physical counterpart three times therefore making a total of 6 times. As for the pure digital learning class, each child would go through IVEG six times and there would be no physical-learning taking place. Therefore it does not matter if pure digital learning or blended learning were to take place, there should only be 6 times of learning for each learning unit. A one-minute learning session is conducted each time learning is taken placing for both digital and physical type of learning. Every time when a question was correctly answered, a score of 10 would be given. At the end of each learning session, the total scores would be summed up, which would then be referred to as the learning outcome of this session.

## **4 Data Analysis**

### **1. The comparisons of learning outcomes among children who partook in blended learning who are of different genders and ages**

An independent-samples analysis of T test was adopted for the analyses. The F value of the learning statistics was 4.37 ( $p = .038 < .05$ ), which is an indication of the obvious difference in learning effectiveness comparing kindergarten boys with girls. It shows that kindergarten boys demonstrate better learning outcomes. As for the learning method, the F value was 12.32 ( $p = .001 < 0.1$ ), which also indicates that blended learning has superior learning effectiveness comparing to pure digital learning.

As for the age difference study, we have included children who are taken from senior level (age 5) and intermediate level (age 4). It can be observed from Table 1 that there wasn't significant correlation between age differences and learning methods as can be seen from F value ( $F = .04, p = .84 > .05$ ). Therefore the individual factor that contributes to significant difference in learning effectiveness was learning method. Age difference of kindergarten children did not play a significant role in this study. The F value of age factor was 1.59 ( $p = .21 > .05$ ). Even though, the means of learning outcomes of senior level children were shown to be better the difference shown still did not reach a level of significance. On the other hand, the F value of learning method factor was 14.10 ( $p = .001 < .001$ ), and it was a valid indicator showing that there is a significant difference in learning effectiveness according to different learning methods. Blended learning in this case demonstrated better learning effectiveness comparing to pure digital learning.

For the blended learning group, the F value of the correlation between the gender and game mode (digital and physical mode) did not reach a level of significance ( $F = .037$ ). However both individual factors (gender and game mode) reached a level of

significance ( $F = 6.588$ ). There was a remarkable difference exhibited by the male children comparing to the female children of the blended learning group. The F value of game mode factor was 8.93, which shows that within blended learning, children learned better during physical sessions comparing to digital sessions. The difference was also significant.

For the blended learning group, the correlation between the age and game mode did not reach a level of significance ( $F = 1.97$ ). As for the contributions by individual factors, despite the fact that game mode reached a level of significance, age factor did not. The F value pertaining to age factor was 0.62, which shows that there was not a direct link between the age of children and the game modes (digital or physical mode). As for the game mode factor, the F value was 7.76 and it indicates that within the blended learning group, children learned better during physical sessions comparing to digital sessions and the difference was significant.

**Table 1.** The descriptive statistics of the digital and blended learning group.

Groups	Digital learning			Blended learning		
	N	M	SD	N	M	SD
Boys	69	132.62	33.19	75	156.87	48.30
Girls	58	129.11	24.63	53	139.65	44.63
Age5	57	135.04	33.23	54	152.81	45.60
Age4	70	127.74	25.91	74	147.50	48.86
Total	127	131.02	29.53	128	149.74	47.41

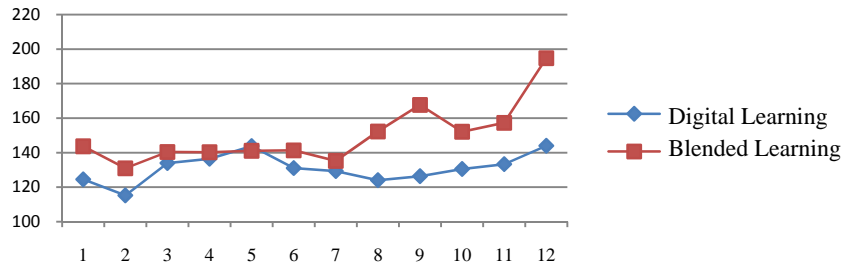
## 2. The comparison of learning outcomes of physical learning and pure digital EIVG learning

An independent-samples T test was adopted for the analyses; t value was 3.38. Therefore we can conclude that physical learning was shown to be much more effective when compared with digital learning.

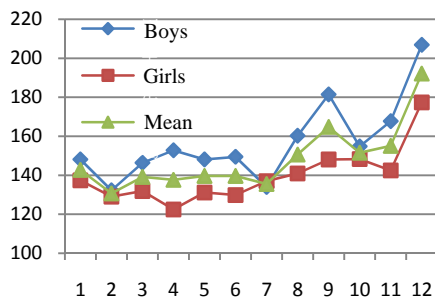
**Table 2.** The descriptive statistics of the blended learning group.

Groups	Digital learning			Physical learning	
	N	M	SD	M	SD
Boys	75	146.20	55.15	167.53	51.53
Girls	53	130.28	55.66	149.03	48.28
Age5	74	133.38	54.08	161.62	55.00
Age4	54	148.15	57.26	157.47	44.93
Total	128	139.61	55.70	159.87	50.85

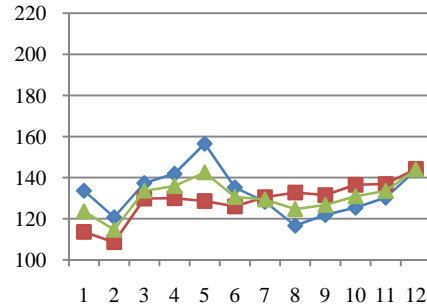
## 3. The study of learning trends of children when repeated learning sessions were given in interactive video learning mode.



**Fig. 2.** Learning trends over the number of learning attempts for blended and digital group.



**Fig. 3.** Learning trends for different genders over the number of learning attempts



**Fig. 4.** Learning trends for different genders over the number of learning attempts

A repeated measures one-way ANOVA analysis was adopted for the analyses. Fig. 2 shows that, comparing to the pure digital learning, the scores of children in blended learning demonstrated an upward trend. Fig. 3 is a trend chart of children with different genders within the blended learning group scoring over repeated attempts of learning specified in a given order. It can be observed that the male children of the blended group demonstrated bigger fluctuations comparing to that of female children of the same group. It shows that the impact on learning results due to getting bored with IVEG was more prevalent in the case of the kindergarten boys comparing to the kindergarten girls. We can identify two major drops in the scoring of male children, one in 2<sup>nd</sup> attempt, one in 7<sup>th</sup> attempt, from Fig. 4. There were three turning points and on the 7<sup>th</sup> attempt, there were signs of getting tired of learning. On the female side, since the 3<sup>rd</sup> attempt, there was a steady improving trend on the scoring. This was an indication that there were more fluctuations on the kindergarten boys than the kindergarten girls. It was probably due to the fact that the kindergarten boys tend to be affected by the learning tools as compared to the kindergarten girls.

## **5 Discussion and conclusion**

### **1. Blended learning provides better learning outcomes than pure EIVG learning.**

Blended learning, which combines the traditional learning and digital learning, has both the strengths of digital technology and the strengths of traditional learning in which students and the teachers both take part interactively. The fun elements of digital learning are combined with the effectiveness of traditional face-to-face learning. Blended learning can also be considered as learner-centered since a learner is provided with greater freedom of customization on how he/she could best utilize the digital technology to enforce his/her learning experience while being instructed in a traditional face-to-face manner [8].

An effective learning method should incorporate media, delivery methods and technology in a holistic manner such that the highest learning outcomes can be achieved. Since EIVG learning system belongs to the type in which more intense body movements are expected, it tends to incur fatigue under prolonged period of usage. Therefore the appropriate insertion of both learning types, namely, traditional and digital learning, is important in striking a balance between interesting learning and effective learning. According to the observation from the instructors, both types of games (digital or physical) can successfully capture the attentions from kindergarten children. However only when blended learning is applied, through the appropriate use of physical and digital games, children tend to develop more self-confidence, more successful rate in drawing connections between various pictures therefore better learning results are achieved.

### **2. The outcomes achieved by boys after trying EIVG are shown to be better than that of the girls. The outcomes of children from senior level and that of intermediate level do not differ significantly.**

In our study, we discover that regardless of pure digital learning or interactive video learning, boys achieve better learning results than girls. The EIVG is of action type and the content of the game belongs to creative type, and boys prefer more actions while girls prefer more creation. Our study combines both elements into the learning system and concludes that the delivery method, which is of action type, plays a more important role than the delivery content, which is of creative type, in affecting the learning of boys and girls.

As for the age difference, according to Piaget's proposed four-phase theory of Cognitive- Development, children of age 4 to 7 belong to the Intuitive stage of Pre-Operational Period. Children in this stage rely on their intuition for problem solving and have not yet developed a sense of Conservation. Generally speaking, as age grows, the types of children games show gradual changes accordingly. Parten holds that the games children play according to age is progressive in nature; from play alone (age 2 to 2.5) to parallel play (age 2.5 to 3.5); from play together (age 3.5 to 4) to play collaboratively (after 4.5).

Our study demonstrates that there is no significant difference existing in learning outcomes caused by the age difference of the kindergarten children in either blended

learning or pure digital learning. One possible cause is that the ages of the participants are too close and both belong to the same phase in Piaget's theory, Intuitive stage of Pre-Operational Period. In the future, when research can incorporate a bigger age group, this can become one of the main topics for further research.

### 3. The children who make repetitive attempts on the EIVG demonstrate better learning trend in the case of blended learning.

Through playing games, children learn to take control on things. Games are also children's main tool for emotional adjustments, through which it is possible to observe the development of children's emotional life [9]. Through the sharing of personal experiences, children can obtain valuable lessons such as respecting others, emphasizing with others, etc. The next phase of EIVS will concentrate on the networking learning approach. This will provide a better picture of how a group of children and teachers can learn through interactions with each other.

It is also important to focus on the game design by including new and interesting features in order to increase both the entertainment and educational value. Furthermore, we could also do specialized research on the impact that EIVG has on the learning effectiveness of students suffered from mental retardation. This study has primarily targeted kindergarten children in Taipei as research objects. In the future, the EIVG can be expanded to accommodate various levels of education. This will enable us to do research on the learning of students across the entire spectrum of educational system and gain a better understanding on the design approach that should be taken for the future EIVGs.

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