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Application of Teams-Games-Tournament Strategy to Investigate Learning Effectiveness in Primary Schools

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Abstract: Mathematics is the foundation course in many fields, but many students are afraid to of it. Determining a method by which to promote the student interest and enthusiasm is still a problem many researchers are trying to solve. However, a lot of studies have found that a combination of mathematics and everyday life things can improve student interest, and the math learning process, combined with appropriate teaching strategies, can enhance learning achievement. Therefore, in this study, addition and subtraction, which are the basis for mathematics and a beginning course, are chosen as the learning content, and Teams-Games-Tournament (TGT) learning strategy is used in the entire learning process. It is expected that students' motivation and interest would be aroused by using game-based learning and that learning performance would be improved as a result of competition in a peer tournament. All of the participants in this study were second grade primary students who used an interactive game-based learning system constructed as a virtual grocery store and combined with TGT learning strategy for the purpose of learning addition and subtraction. The results of the experiment indicated that the students who used the proposed learning system with the TGT learning strategy had higher performance during the learning process and that interactive game-based learning can effectively promote motivation and attitude toward a math course.

Keywords: Addition and Subtraction, cooperative, Teams-Games-Tournament, game-based learning, learning performance

1. Introduction

Previous studies have indicated that motivation will enhance the enjoyment of learning (Johnson & Johnson, 1990; Jacob, 1999; Huang, Huang, & Wu, 2014) and that this in turn will improve learning achievement. The characteristics of game-based learning include interactivity, enjoyment and liveliness (Mayer, 2003; Lisi & Wolford, 2002), among others. If these characteristics along with instruction are combined and implemented into a pedagogy, this will result in a learning environment with little pressure that is enjoyable as well.

In the area of multiculturalism, cooperative learning strategy became a popular learning method starting in 1970 (Johnson & Johnson, 1990). Cooperative learning was connected with the peer cooperative relationship and sharing in order to achieve shared personal and group learning goals (Mentz, Walt, & Goosen, 2008). In cooperative learning strategies, Teams-Games-Tournaments (TGTs, as presented by David Devries and Keith Edwards in 1970, have been used to promote learning performance among peers. Slavin (1995) also indicated that TGT strategy has a structured pedagogy that is independent of the learning context, e.g. mathematical computation and applications, sentence patterns, geography and graphical skill, and science concepts.

The TGT strategy has been implemented in kingdom and at the first grade level. The results indicated that TGT positively affects mathematics learning (Jacob, 1999).

Two effects of game-based learning (GBL) are the provision of interaction and the development of intrinsic motivation. Learners either work alone or in group activities in the interactive learning

environment, and learning performance is enhanced through their operative experience and interactive communication with each other (Mayer, Mautone, & Prothero, 2002). Thus, learning achievement of game-based learning strategy comes from experience in games and is a result of immediate feedback. Learning through games initiates tournaments and cooperative as well as fun, entitlement, and overwhelming (Prensky, 2001). Moreover, interdependence and personal responsibility for individual performance exist between members in the group learning and competition process (Johnson & Johnson, 1994; Slavin, 1981). Group learning can consist of both active participation in learning activities and interaction with situations. Cognitive structures and fundamental models are constructed based on situations. In addition, learning in situations also stimulates reflection and problem-solving skills (Brown, Collins & Duguid,1989; Huang & Wu, 2010; Huang, Huang, Huang, & Lin, 2011).

When situations are integrated into in-class learning environments, interactive game-based learning not only enhances learning motivation but also helps learners immerse into the interactive learning environment. Interactive learning includes good instruction and a multimedia environment, and some design concepts, like "learning by doing," "interaction," and "cooperative." In such a learning environment, learners will find it easier to enhance both their learning performance and motivation. Instructional activities based on a game-based learning environment involve structuring the learning content and integrating the knowledge structure instead of attempting to obtain a pure recreational effect (Druckman, 1995; Eskelinen, 2001).

This study combined digital games, situational learning, and mathematics instruction as well as the design of a life-oriented virtual shop. In the game-based learning environment, learners simulate trading activities in order to learn addition and subtraction skills. Moreover, the learning environment integrates the TGT strategy into the game. Learners will use the TGT learning environment to promote constructive competition with their peers and to promote learning aspirations. The TGT strategy has funny and interactive characteristics that will attract active learning, promote learning motivation, and enhance learning performance. In this study, the experiment participates are the second grade students. This study investigates the learning effect between general game-based learning and life-oriented virtual shop game-based learning.

2. The TGT Strategy Method for Addition and Subtraction

2.1 Teams-Games-Tournament, TGT

The main characteristic of TGT strategy is a focus on team-game tournaments after the learning instruction. Before the games, learners are divided according to ability, gender, and so on. Each group includes three to six persons. All of the groups initially do interclass learning by themselves. The team game tournaments are implemented after the interclass learning. They have to invent a game to get 20 points in the tournament process. Five games lead to a total score of 100 points. Each game scores student performance in lieu of a paper-based test. In the final step of the TGT process, the total score for each group is recorded. Moreover, the teacher praises the winning groups in order to motivate the students. This process consists of both personal learning and group performance as well as increasing the interaction among peer groups. The TGT process is shown in Figure 1.

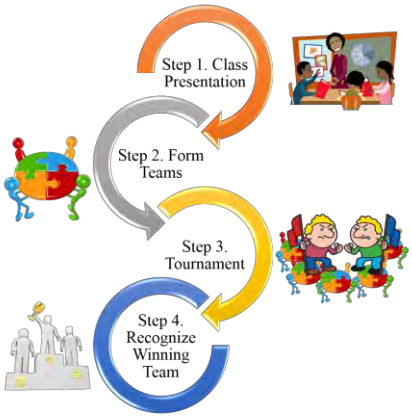

Figure 1. The TGT strategy learning process

2.2 TGT Platform- Addition and Subtraction

The aim of this study is designing a game-based TGT learning system for addition and subtraction. The learning system can assist primary students with learning addition and subtraction. Group ranking of is one function in this learning system. This function will help the tournaments held among the students promote group motivation. In this system, a virtual shop function is designed for real grocery store situational learning. Learners can use the system, which resembles a real-life experience, to learn addition and subtraction skills. Figure 2. shows the platform for the game-based TGT learning system for addition and subtraction.

a.) The virtual store interface

b.) Ranking interface

Figure 2. Illustration of the TGT learning platform

3. Experimental Environment

3.1 Participants

The participants in this study are second grade primary students. They are randomly divided into two groups. One group is the control group (n=27), and the other one is the experimental group (n=28). The control group is learning with general game-based learning. The experimental group is learning with game-based TGT learning. Both groups are learning addition and subtraction with the same teacher.

3.2 Experimental Procedure

This study experiment was conducted for 240 minutes in order to investigate the experimental activities with the experimental group and the control group and to evaluate their learning performance. A teacher with five years teaching experience was invited to conduct the teaching of addition and subtraction. Before the experiment, in order to determine the changes in the comprehension level in the two classes regarding addition and subtraction through the experimental design, prior to the teaching of addition and subtraction, a mathematics addition and subtraction pre-test was conducted. Before the experimental process, the two groups were instructed in mathematics addition and subtraction and in system operations. There were two classes 40 minutes long each week. In the experimental process, the experimental group used a game-based learning system with the TGT strategy. The control group used the traditional game-based learning system. At the end of the experiment activities in the last week, a post-test and attitude questionnaire related to addition and subtraction was given to the students to determine their learning performance and their attitude after implementing the experimental activities (as shown in Figure 3).

Attitude toward mathematics affects learning performance. A positive attitude toward mathematics causes students to spend more time and effort on learning mathematics as well as helping them become effective learners, and vice versa in the case of students who have negative attitudes toward math (Ma & Kishor, 1997). Aiken (1970) indicated that attitude and achievement mutually influence the learning of mathematics. Corbo (1992) also indicated that attitude toward math is significantly different in the case of learners at different levels. Some researchers have pointed out that mathematics performance is related to achievement. For the purposes of this study, an existing mathematic attitude questionnaire was modified. The questionnaire had 24 items and was scored with a five point Likert scale. This questionnaire is used to investigate the relationship between attitude toward mathematics and achievement.

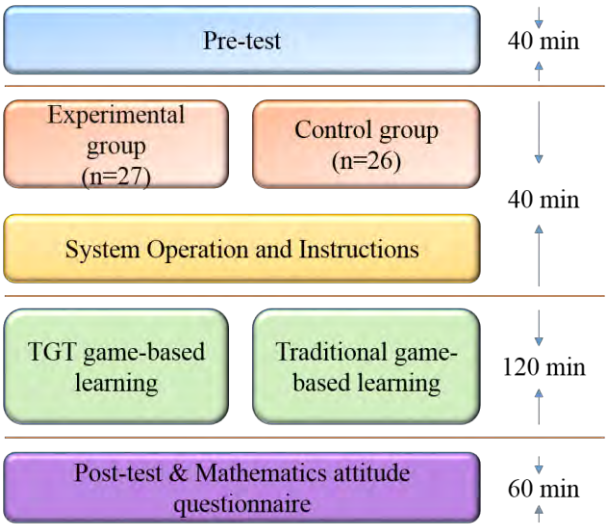

Figure 3. The experimental procedure

4. Results and Analysis

4.1 Learning Achievement

In order to investigate the differences between the two groups, a learning achievement pre-test was essential. The pre-test was used to ensure the ability to measure learner achievement differences. A t-test was used to evaluate the results of the pre-test. The experimental group's mean and standard deviation were 75.11 and 9.07, respectively. The control group's mean and standard deviation were 73.69 and 9.73, respectively. The variance in the t-test was .548 ($p>.05$). The results of the pre-test

indicated that there were no significant differences between the two groups. Their learning achievement was at the same level before the learning activity. Therefore, the learning activity could be implemented.

After the learning activity, a post-test was scored and an analysis of covariance (ANCOVA) was used for analysis in order to investigate the effects of the activity on learning achievement. In the analysis process, the pre-test score was the covariance variable and the learning method was the independent variable. The analysis results are shown in Table 1. In the post test ANCOVA analysis, the mean, standard deviation and adjustment average for the experimental group were 85.33, 7.63 and 85.17,. The mean, standard deviation and adjustment average for the control group were 76.65, 8.72 and 76.81, respectively. These results indicated that there were significant differences between the experimental group and the control group ($F=7.284$, $p<.05$, as shown in Table 1). The results indicated that the experimental group and control group were significantly different in the post test. The mean for the experimental group was higher than that of the control group. This result also can be interpreted to mean that game-based TGT learning was superior to general game-based learning with regard to learning achievement. On the other hand, the standard deviation for the experimental group was lower than that of the control group. This means that the learning difference in the experimental group was smaller than that of the control group. Therefore, game-based TGT learning promoted learning achievement and lower learning differences among peers.

Table 1. The post-test ANCOVA analysis

Group	N	Mean	SD	Adj.	SE	F
Experimental	27	85.33	7.63	85.17	3.09	7.284*
Control	26	76.65	8.72	76.81	3.09	

*$p<.05$

4.2 Mathematics Attitude Questionnaire

From the mathematics attitude questionnaire shown in Table 2, a t-test was used to ensure differences between the two groups. The results indicated that the two groups were not significantly different. The possibly reason for this result was that both two groups used a game-based learning system and the participants were primary students. Aikden (1970) reported that mathematics attitude and achievement have a relationship at the primary school level, but the relationship is not significant. This result also echoed Wenger's (1992) report. The results of Wenger's study indicated that learners with high levels of positive attitude toward mathematics have better ability than those with low levels of positive attitude. The results also indicated that mathematics attitude was not positively related to mathematics achievement. Therefore, both groups' attitudes toward mathematics were not significantly different.

Table 2. Descriptive statistics for mathematics attitude questionnaire

Group	N	Mean	SD	*t*
Experimental	27	4.18	3.21	1.72
Control	26	3.97	4.17	

5. Conclusions

This study investigated game-based TGT learning of addition and subtraction. The learning environment was a combination of game-based learning, team tournaments and virtual shop trading. The teams invented games in the learning environment. Mutual survival and personal responsibility were learned by inter-group relations. The results indicated that TGT game-based learning achievement was higher than general game-based learning. Thus, constructive competition promotes peer learning and learning achievement. Hence, the two groups were not significant different in terms of attitude toward mathematics. Related work is in progress, and qualitative research will be used to collect interview data. Participant information (e.g. learning motivation, math anxiety, etc.) will be collected in the future in order to investigate the mathematics learning status of students.

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