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Application of Tabletop Games in Fire Safety Education for Elementary School Students with Special Needs: A Case Study in Taiwan

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Abstract: ***Disaster prevention education in elementary schools in Taiwan currently lacks complete teaching packages and only uses general storytelling teaching approaches. Therefore, in order to inspire students, this study aims to use tabletop games focusing on fire safety to facilitate and improve disaster prevention education. For the samples, some students with special needs in an elementary school in Hsinchu County are included in the teaching study. In addition, the students are randomly divided into experimental and control groups to differentiate the learning effects. The experimental group will be taught with tabletop games, while the control group will receive general teaching approaches. In addition, a statistical test is applied to analyze the differences in students' learning effects. The results of this study show that the application of tabletop games in fire safety education can significantly improve students' learning effects, as well as enhance their learning motivation and concentration. Moreover, it can increase the opportunities for peer communication in the classroom and create a happier learning environment.***

Keywords: disaster prevention, fire safety, tabletop games, students with special needs

1. Introduction

The term "students with special needs" in Taiwan's "Special Education Act" refers to those who, after professional evaluation and identification, have special learning needs due to physical or psychological disabilities and require the support of special education and related services. However, the special education students in this study are only those with psychological learning disabilities, such as mental retardation and attention deficit hyperactivity disorder.

In general, special education students in elementary schools are not very motivated and willing to learn. However, children's nature is to play, and learning according to their nature is the most natural and effective way of education, and also the greatest motivation for children to learn. Therefore, this study uses tabletop games on fire safety as a teaching tool for special education students in elementary schools. To find out if the students' academic performance can be improved and what positive effects can be found.

2. Literature Review

This section discusses relevant research on the integration of tabletop games into education for various fields in recent years:

Zaini et al. (2019) identified the user requirements of preschool children in developing the model of game-based learning in fire safety. Their study involved six preschool children and showed the engagement of children in learning fire safety through game improved their knowledge, behavior and psychomotor skills. Moreover, their study makes an important contribution in determining the usability on the level of effectiveness towards preschool children through active learning.

Maffia and Silva (2021) proposed a study aimed at teachers' professional development in terms of their assessment practices in mathematics teaching and learning. Their project is based on the use of the tabletop game 'Shut the box.' They present the results of the administration of this questionnaire showing a relation between teachers' beliefs about educational use of tabletop games and their beliefs about mathematics teaching and assessment.

Yang et al. (2021) designed an interactive tabletop game for university students to involve them in learning 'Introduction of computer science' more actively. Their 10-week research adopted a single-group pretest-posttest design experiment, and forty-two participants were involved. Their results showed the tabletop game was able to enhance students' learning, with positive results in terms of their evaluation of the enjoyment of the game, and significant differences achieved in their learning motivation and achievement.

Chen and Wang (2021) investigated the influence of primary school students' learning motivation and interest while using tabletop games in teaching the unit of mathematics, 'highest common factor and least common multiple.' The participants involved in this research are 40 grade-sixth students from some elementary school in Miaoli County, Taiwan, with 20 students in the experimental group who received 'integrating tabletop games with mathematics learning,' and the other 20 students in the control group who received 'traditional pedagogy.' Their analysis reveals that it is useful to encourage students to use their professional knowledge, inspire self-reflection and enhance leaning interest through the approach of integrating tabletop games into mathematics course.

Elviana et al. (2022) aimed to examine the effectiveness of educational games called fire safety games on fire safety

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towards the knowledge of fire safety behavior among vocational students. Their study uses experimental research with a 'pre-post' test design involving 38 participants who fit the inclusion criteria. Participants have randomly divided into fire safety games only 19 participants, and the fire safety game combination with PowerPoint slides consisted of 19 participants. Their result showed significant differences in the two groups' knowledge of fire safety to prevent fire between the two groups. Their results indicate that the fire safety game can be used as a learning device to increase fire safety knowledge.

Chen et al. (2022) aimed to review and examine the effects of tabletop games on cognition in older adults. In older adults with intact cognition, tabletop games had positive effects on their global cognition. In older adults with cognitive impairment, significant differences were found in global cognition. Tabletop games had the characteristics of cognitive training and interpersonal interactions. For older adults, in addition to improving cognitive functioning, tabletop games also increased their social participation and interactions.

In conclusion, all of the research discussed above shows that tabletop games can be used in various educational settings and subjects; and positive learning effects are shown in most of them.

3. Methodology

3.1 Experimental and Control Lessons

The "MatchCat" fire survival tabletop game developed by the Taiwan Design Research Institute (TDRI) is used in the experimental teaching of this study, as shown in Figure 1.

Figure 1: MatchCat tabletop game
Source: TDRI website (tdri.org.tw)

There are two independent variables in this study. One is the teacher's use of general narrative instruction, as shown in Figure 2, and the other is the use of the tabletop game MatchCat, as shown in Figure 3.

Figure 2: General teaching scene

Figure 3: Scene of a tabletop game lesson

In order to reduce the influence of factors other than independent variables on the experimental results, the other variables in this study are set the same in both teaching approaches. They are:

- Teacher: The teacher of the experimental group and the control group are the same, who maintain consistent teaching attitudes and styles.
- Teaching time: Both the experimental group and the control group are taught in one lesson (40 minutes) per week for a total of three weeks.
- Assessment questions: Both the experimental group and the control group use the same after-class evaluation questions.

The teaching subjects of this teaching study included 16 students, 8 in fifth grade and 8 in sixth grade, and all of their disability conditions are learning disabilities. In this study, 4 students from each of the fifth and sixth grades were randomly selected as the experimental group, and the other 4 students from each grade were randomly selected as the control group, as shown in Table 1.

Table 1: Samples of this study

Group	Fifth grade	Sixth grade	Total
Experimental	4	4	8
Control	4	4	8

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3.2 Statistics and Tests

The coefficient of variation (CV), also known as the dispersion coefficient. It is a normalized measure of the degree of dispersion of the probability distribution. It is defined as the sample standard deviation s divided by the sample mean $\bar{x}$ and its calculation formula is given below (Weiss, 2015):

$$CV=s/\bar{x} \quad (1)$$

The coefficient of variation can usually be used to compare multiple populations. By comparing the magnitude of the coefficient of variation, the stability or representativeness of the averages of different populations can be explained. The smaller the coefficient of variation, the better the representativeness of the average. Note that the coefficient of variation is defined only when the mean is not zero and is applicable when the mean is greater than zero.

Moreover, to test the mean of two independent small samples, the t-test of the mean of two samples, is designed to compare the difference in mean between two parent groups with the same variation, or to compare the mean of two independent small samples from the same parent group (Starnes et al., 2014). And the sample condition of this study belongs to the former.

The null hypothesis and the opposing hypothesis are listed as follows,

$$H_0: \mu_{control} = \mu_{experimental}$$
$$H_1: \mu_{control} \neq \mu_{experimental} \quad (2)$$

If the test statistic t falls in the rejection region, the null hypothesis H0 is rejected. This means that the mean score of the experimental group is significantly different from the mean score of the control group.

4. Study Results

This classroom study will be conducted every Tuesday and Thursday after lunch from January 3, 2023 to January 19, 2023. The results of the study will be analyzed using MS Excell 2019. First, the mean and coefficient of variation of the two groups of samples are calculated as shown in Table 2. The results show that the mean score of the tabletop game teaching group is 93 points after rounding, which is much higher than the 78 points of the general teaching group. In addition, the coefficient of variation of the results of the tabletop game teaching group is 0.048, which is much lower than the 0.099 of the general teaching group, which means that the learning results of the tabletop game teaching group are more stable than those of the general teaching group.

Table 2: Analysis of the fire knowledge learning test

Group	Control	Experimental
Average	77.75	92.875
Standard deviation	7.722878812	4.517821852
CV	0.099329631	0.048644111

A small sample t-test is also performed on the difference between the two population means, assuming equal population variation. The results of the hypothesis test are shown in Table 3. It shows that the two-tailed P-value is 0.000292653, which is much lower than the significant α-value of 0.05; and it means that there is a significant difference between the two population means. The test result means that there is a significant difference between the mean scores of different teaching groups.

Table 3: Statistical test results

	Control	Experimental
Average	77.75	92.875
Standard deviation	59.64285714	20.41071429
Number of observations	8	8
Pooled Standard deviation	40.02678571	
Hypothetical mean difference	0	
Degrees of freedom	14	
t-statistic	-4.781344332	
P(T<=t) one-tailed	0.000146327	
Critical value: one-tailed	1.761310136	
P(T<=t) two-tailed	0.000292653	
Critical value: two-tailed	2.144786688	

5. Concluding Remarks

According to this study, the application of tabletop games in fire safety education can improve the learning effects of elementary school students, as the fire safety knowledge learning outcomes of students in the tabletop game teaching group are significantly better than those of general teaching approaches. In addition, it is found that in order to win the games, students pay attention to actively participate in classroom activities and pay more attention to study. Meanwhile, the application of tabletop games in teaching is welcomed by students, and teachers can use it to create a pleasant learning atmosphere and stress-free learning environment. Moreover, it can also improve students' social and oral expression skills in the process of playing tabletop games.

However, since this study is only conducted with senior grade special needs elementary students, it is recommended that future research can conduct middle grade and lower grade special needs students to ensure s full understanding of teaching effects. In addition, other disaster topics such as earthquake, typhoon, etc. are also recommended to be conducted.

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