Collaborative Assistive Technology in Mathematics Learning for Students with Special Needs

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Abstract
This study is an interactive and collaborative assistive technology in mathematics learning for students with special needs. The participants in this study were 3 first grade of elementary school students who with autism spectrum disorder, intellectual and developmental disability and developmental delay respectively. The purpose was to promote interpersonal interaction, active participation, and understanding in mathematics for students with special needs. The researcher has used 3D printing adaptive switches and modified toy combined with addition and subtraction arithmetic, to advance their interpersonal interact, participative of initiative, and comprehension of mathematics. Description of design activity：1. Introduced students to 3D printing adaptive switches and modified toy. 2. Guide students to calculate the number of small fish on the modified toy. 3. Game descriptions. 4. Students are divided into 2 groups, one person operates the adaptive switch and the other is responsible for fishing (This section has student assistants participating in the grouping). 5. Write mathematical problems on the blackboard. 6. Assist students to operate and compete. 7. Sharing and giving feedback after the event is over. During the process, improve students' learning performance through specific operations; the emphasis on team cooperation, to cultivate more cooperative behavior; improve learning motivation through interesting teaching materials. Via case study paradigm, collect professional advice and feedback from their participants and special education teachers.

Keyword：assistive technology, adaptive switch, students with special needs

Introduction

Technological advancements have been achieved one after another in the 21st century. The number of users of assistive technology continues to increase and this makes choice and application of appropriate assistive technology devices and services all the more important. The condition of each user has to be taken into account, including individual characteristics, preferences, perception and attitude, in order to prevent users from abandoning assistive technology as consequence of unsatisfactory results.
It is pointed out in the study by Badian (1999) that close to 7% of students have trouble learning math. Among students with special needs, whether in learning math or other subjects, the ratio of learning difficulty is even higher. Unified teaching and progress is often emphasized in the courses of regular classes and the individual differences and needs of students with special needs are neglected (Hou, 2004). Under such circumstances, students with special needs are unable to catch up with the progress and eventually have to be removed from regular classes and put in special education or resource classrooms for individualized instruction.

At present, application of assistive technology in special education continues to develop and bring a variety of positive influence on learning and everyday life for children with special needs. However, considerable differences exist between such children. They face dissimilar problems and needs. For this reason, particular design and modification are required in application of assistive technology in special education, whether regarding teaching materials and instruments or teaching strategies, to help children with special needs to learn more effectively.

Studies conducted by scholars have indicated there are four reasons why students have low achievements in math learning, including math being difficult to comprehend, math learning being boring, math learning making them feel lonely and math being inapplicable in daily life. Therefore, improving learning motives, simplifying math-teaching strategies, increasing the fun in learning and applicability in everyday life, and making it possible for students to learn through teamwork can improve the effect of learning for students (Liang, 2011). Meanwhile, games are an important part in children's life. Incorporation of games in teaching can achieve the following: 1) making learning more fun, 2) eliminating external purposes, 3) turning learning into a voluntary, active and free choice, 4) stimulating enthusiasm in participation and 5) linking learning to things in daily life (Liebmann, 1991). Integration of technology and games is bound to become an important direction in special education. The authors of this paper have applied the abovementioned concepts in special education. Through integration of assistive technology and games, the motives of students for learning math have been improved. Learning through teamwork has promoted interactions between children with special needs. Students have improved their ability to comprehend mathematics and associate their learning with everyday life.

Method

The case study method was adopted. Teaching activities were particularly designed while assistive technology and toy games were integrated to conduct learning intervention. Special switches produced with 3D printing were used in combination with modified toys and applied in addition teaching for first graders. Students

cooperated to calculate and answer math questions. Afterwards, the professional suggestions and feedback from special education teachers participating in the activity were obtained.

Study Subjects

The study was performed on three first graders with special needs. Their handicaps were respectively autism spectrum disorder(ASD), developmental delay (who was suspected as intellectual and developmental disability), and intellectual and developmental disability(IDD). The two students with development al delay and intellectual and developmental disability had been pulled out of regular classes and put in the special education classroom for math learning. The other student with autism spectrum disorder had been assessed by the special education teacher as needing interaction ability enhancement and was therefore included in this study to improve the ability to interact with others.

Study Instruments

1. Special switches produced with 3D printing
The team called Excellent Assistive Technology, AxcellenT for short (see Fig. 1), created by the graduate institute the authors are attending designs and produces various special switches in accordance with the conditions of different children with special needs, including push switches, wobble switches and pull switches (see Fig. 2). Such special switches are pressed to activate modified toys. In this study, the participants had to activate modified toys through teamwork to execute their missions. In order to help more children with special needs, AxcellenT offer the public to use its special switches design for free service (see Fig. 3).

Fig. 1 Axcellent website

Fig. 2 Various Switches

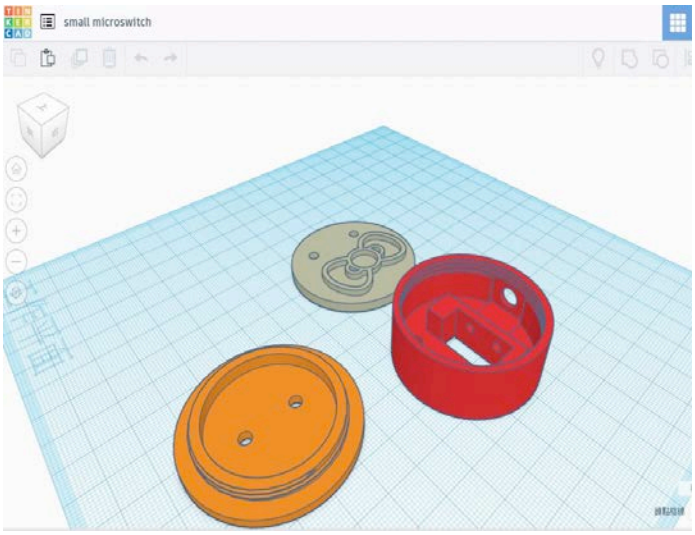

Fig. 3 Public Special Switches Design

2. Fishing toys available on the market

The power source for the motor of fishing toys available on the market was modified (see Fig. 4), so that a special switch could replace the power source and the toy could be activated by pressing the special switch

Fig. 4 Toy Modification

3. Audio cables

The audio cable is an important medium to connect and activate special switches and modified toys. After each end was hooked up, the participants could activate the toy by pressing the special switch (see Fig. 5).

Fig. 5 A modified Toy and a Special Switch Connected with an Audio Cable

Teaching Process Description

1. Introducing the special switches and rotating fishing toys

In their daily life, many people with physical and mental disabilities are unable to operate different objects, such as household appliances, toys, environmental control equipment, etc. With special switches complying with their needs, these people will be able to reduce the gap between them and the environment and even improve their connection with the outside world. Hence, it is particularly important that the purposes of special switches and how they are to be used have to be explained to the participants (see Fig. 6).

Fig. 6 Introduction of Special Switches and Rotating Fishing Toys

2. Guiding students to count the quantity of fish in the fishing toy

Many people have the experience of counting from one to one hundred in childhood. Learning math is learning language. Making the participants count the quantity of fish can help develop their mathematical language and improve their calculation ability and cognitive integration (see Fig. 7).

Fig. 7 Students Counting the Quantity of Fish in the Fishing Toy under Guidance

3. Game explanation:

Due to the disability and age of the participants, the game was explained without using difficult words. Simple and structural explanations were given to assure the participants could fully understand the rules of the game and how the game should be played (see Fig. 8).

Fig. 8 Game Explanation

4. Grouping

The participants were paired up, one to operate the special switch to activate the toy and the other to do the fishing. Since there were three participants, a volunteer who was a university student had to be included to complete grouping (see Fig. 9).

Fig. 9 Grouping and Discussion

5. Display of mathematical questions on the blackboard

Initially, a simple one-digit addition question (2+1=) was written on the blackboard for demonstration. After it was certain that the participants really understood the game and how to operate the toy, the actual teaching began and questions were given (see Fig. 10).

Fig. 10 Game Explanation

6. Students operating the fishing toy under assistance to engage in a competition

Addition questions appropriate for first graders were written on the blackboard for the team members to discuss and find the solutions before the number of fish corresponding to the solutions were to be fished out. The participants had to activate the modified toy and start fishing through teamwork. The team member responsible

for pressing the special switch had to continue to press the switch for the fish to turn and open their mouths, so that the one in charge of fishing could catch the fish (see Fig. 11).

Fig. 11 Students Operating the Fishing Toy under Assistance and to Engage in a Competition

7. Participants sharing experience and giving feedback after the activity ended
After the competition ended, the participants were praised for their performance and also given the opportunity to share experience and give feedback about the activity (see Fig. 12).

Fig. 12 Experience Sharing and Feedback Giving

Conclusions and Suggestions

Application of assistive technology integrated with games in special education has gradually become a tendency. Based on the study process, observations and feedback from the special education teachers of the participants, the authors have come up with the following conclusions and suggestions:

Conclusions:

1. Design of interesting teaching materials and teaching methods in combination with integration of assistive technology and games can improve the motives of children with special needs to learn.
2. When teamwork is stressed to encourage children with special needs to cooperate, such cooperative learning can increase the opportunity and ability of students with special needs to interact with others.
3. Actual operation of assistive technology devices, besides improving the ability of children with special needs to comprehend and calculate, can also help them apply what they learn in daily life and upgrade their cognitive abilities.
4. This teaching method is easy to understand. Parents of students with special needs can learn to apply it to allow their children to operate the game at home.
5. Post-activity reflection is emphasized, so that related experiences can be accumulated to lay the foundation for improvement of mathematical knowledge.

Suggestions:

1. The instruments used in this study can be adopted to develop more teaching approaches, such as for subtraction calculation, continuous application of addition and subtraction, etc. to enhance the mathematical comprehension and application of students with special needs.
2. The teaching method using games is not suitable for every student with special needs. Assessment of the condition of each student is required to determine whether the method is appropriate.
3. The time of teaching method using games also needs evaluation. If students with special needs have other classes afterwards, learning by playing fun games may cause them to make comparisons with subsequent classes and they might not be able to learn effectively as a result of loss of attention or physical exertion. For this reason, it is recommended that the teaching using games can be conducted before lunch break or during the last class of the day.

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