

Developing the Concept of Money by Interactive Computer Games for Autistic Children

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Abstract

Autism is a general term used to describe a group of complex developmental brain disorders known as Pervasive Developmental Disorders (PDD). It is a life-long disability that prevents people from understanding what they see, hear, and sense. This results in severe problems with social relationships, communications, and behavior. Autism is typically diagnosed between the ages of two and six, although variations of ASD (Autism Spectrum Disorders) can sometimes be diagnosed earlier or later [1]. Children with learning disability such as autism who have serious impairments with social, emotional and communication skills require high degree of personalization in using the educational software developed for them. In this paper we present a personalized game based on digital story-telling concept that helps the children of age ranging from 9 to 14 years old with autism to understand the use of money. It also teaches the autistic children the social behavior appropriate while shopping. The game is developed on BYOB (Build Your Own Block, an advanced offshoot of the game engine Scratch).

keywords - Learning Disability, Autism, ASD, Digital Story Telling, and Money.

1 Introduction

The term learning-disability is a classification including several disorders in which a person has difficulty learning in a typical manner, usually caused by some unknown factor or factors. The unknown factor is the disorder that affects the brains ability to receive and process information. This disorder can make it problematic for a person to learn as quickly or in the same way as someone who is not affected by a learning disability. Children with learning disability

are often found as smart or even smarter than their peers. But they may have difficulty in reading, writing, reasoning, recalling, and organizing information if left to figure things out by themselves or if taught using the conventional teaching methods.

Autism is one of the groups of serious development problems known as autism spectrum disorders (ASDs) that cause substantial impairments in social interaction and communication resulting in unusual behavior and interests. It is learned that out of every 94 boys, on average one is affected by Autism. For girls, it is one in every 150. In Bangladesh, no research has been carried out but it is assumed that about 3,00,000 children are affected [2].

The autistic children suffer from a variety of communication disorders including but not limited to non-responsive to questions, low voice, uttering of irrelevant words, repeating sentences, lack of the sense of turn taking, etc. Understanding the concept of money and proper use of it is another important area where they show general lacking. In order to start learning how to use money, the children need to recognize the meaning of the currency notes and coins. While working with autistic children from a local institute, we have observed a group of autistic children age ranging from 9 to 14 years old have difficulty to carry out the calculation with money in the shopping mall due to their learning disability. Although they are familiar with numbers and are able to perform basic arithmetic operations with them, they are unable to relate the same task with money.

One of the most strongly recommended approaches for teaching autistic children is to use the visual aid. Empirical studies have shown that pictographic and written cues can often help them to learn and communicate effectively. Digital story telling (with personal connection) can use engaging multimedia formats and is proven as one of the most effective tools for the purpose. It is flexible and creative, individualistic and visually attractive. Thus digital story-

telling fits the characteristic learning styles of ASD affected children [3].

In this paper, we will discuss games that we have developed on BYOB to teach the children with learning disability the concept of money and how to use money in the shopping mall. The game also teaches them social behavior appropriate in the shopping mall.

2 Previous Works

The learning style of different autistic children varies a lot and they require a very high degree of customization and personalization in using the educational software and games. There are many products in the market such as educational CD-ROMs as well as free educational software and games from the internet for autistic children. But many software and technologies in the educational and entertainment domains that can benefit people with ASD actually target a wider range of cognitive disabilities. Products and prototypes designed specifically for people with autism range from web-based instructions [4], language related skill enhancement [5, 6, 7, 8], robotics [9], virtual peers [10], facial expression recognition [11], virtual reality simulations [12], cooperative games [13], video modeling [14], play support [15], activity schedules [10], and other assistive technology devices.

Computer software play an important role in facilitating education for children with autism. It is found from previous studies that children with autism spent more time on reading materials when they accessed it through computers and were less resistant to the use of technology in learning. Studies have demonstrated the effectiveness of computer-based training for teaching a variety of skills to children with ASD [5, 14, 16]. Some reasons for this easy acceptance and effectiveness are identified by the researchers investigating technology solutions designed for people with ASD include:

1. Software programs can accommodate the similarity requirements for the ASD affected people by being predictable and familiar [5].
2. Tasks can easily be repeated with very little change from one exercise to the next. In other words, software do not get impatient with repetition [5] and can be implemented to provide dialogue prompts and reinforcement consistently [4].
3. Most software and technologies work through a visual interface, for example, the Graphical User Interface (GUI) of a personal computer, which capitalizes on what many consider a strength of the target audience [4, 17].

4. Much of the software delivered in computer-based training eliminate the social complexities of interaction with others and allow users to work at their own space [18].
5. Educational software for the personal computer platform can deliver a one-on-one structured learning environment, which is often required for children with ASD to electively learn a topic [5].
6. Software can provide readily available and affordable teaching tools, which augment off-line learning facilities that children and adults can access at home or school, thereby addressing the shortage of instructors needed for intensive one-to-one teaching for autistic people.

3 Our Works

After working with some autistic children of age 9 to 14 years old in Autism Welfare Foundation, Bangladesh for six months, we have observed that some of them have difficulty in understanding the concept and use of money in the shopping centre due to their learning disability. Although they are familiar with numbers and are able to perform basic addition and subtraction, they are unable to relate the same task with money. We have seen that they have the tendency to memorize certain pattern but they do not recognize money if picked randomly. While same amount of money is shown to them using different sequence of notes, they face confusion in calculating the correct total amount.

To alleviate the issue, we have developed a personalized game based on digital story-telling concept that helps the children with autism to understand the concept of money. It also tries to teach the autistic children the social behavior appropriate in the shops. The game is developed on BYOB (Build Your Own Block, an advanced offshoot of Scratch) and can be run on any Windows platform. Our game is organized in multiple levels. It enables the children to play the role of a customer. They can also play it along with an instructor if necessary.

3.1 Objectives

The objectives of our game are as followed:

1. Money identification
2. Buying single item
3. Buying multiple items
4. Learning money exchange
5. Picking different combinations of money

6. Taking decision after shopping is finished
7. Teaching greetings, social behavior in the shops

3.2 Game Overview

3.2.1 Money Identification

To begin with our game, we have made a tutorial for money identification by the children. In this tutorial section, both the front and rear view of different currency notes are shown multiple times randomly (Fig. 1(a)). For each note, four corners of it where the amount is written are zoomed in to teach them to focus on the written amount and not to be confused watching the images or figures on the note.

In the game section tests are taken in 2 steps:

Step 1: Currency notes appear on the screen randomly and the player is asked to select the accurate amount by clicking on the buttons (Fig. 1(b)). After each try, position of the buttons is changed. Same question is also asked in different patterns so that the child cannot give answer only by memorizing the question type or position of buttons without actually knowing the correct answer.

Step 2: In this part, we show four notes on the screen as shown in Fig. 1(c) and the player is asked to select a specific note. An animated puppet tells him *Correct* or *Incorrect* depending on his selection.

3.2.2 Learning Money Exchange

We have divided the money exchange learning phase into four different levels as described below:

3.2.3 Level 1:

Level-1 of our game includes buying a single item from a collection of six items with only a single note. The steps mainly include:

1. Clicking on a single item from a collection of six items (Fig. 1(d)).
2. After selection, the user can either buy it or cancel and choose another item.
3. After deciding to buy an item, click the buy button for confirming the purchase.
4. After that, click the note as a price for that item.
5. After buying, the item is removed from the shelf and placed on the cart so that it becomes evident to the child playing the game that he/she has bought it.
6. Exchange of greetings between the player and the shopkeeper takes place (Fig. 1(e)).

7. As a final step, exchanging money between the player and the shopkeeper is focused clearly so that it gets to the player's mind that giving money to the shopkeeper after buying the item is mandatory.

The items as well as the price of the items are chosen randomly so that a fixed pattern does not get developed into the player's mind. The background of the shop also comes randomly.

3.2.4 Level 2:

Level-2 of our game includes buying a single item from a collection of six items with four notes provided to the player randomly. A wallet is viewed and when it is clicked these four notes appear on the screen.

Among these four notes shown in Fig. 1(f), two notes match with the price of the displayed items and two don't. This is done with a view to testing whether the player can match the price of his selected item to at least one of his owned notes. The player fails to buy the item if the item price does not match with any of his notes or he tries to pay an amount that doesn't match the selected item's price.

3.2.5 Level 3:

In Level-3 the player can buy multiple items from a collection of items one by one (Fig. 1(g)). To buy an item the player has to spend money from the purse which contains four notes initially. Once an item is bought it is shown in the cart. Notes in the purse are generated randomly.

3.2.6 Level 4:

In this level, the player will choose the desired price using various combinations of notes (Fig. 1(h)). It shows four different notes, each note appearing four times in the wallet. A hand is shown which represents the shopkeeper. Whenever a note is selected, it goes to shopkeeper's hand and this amount gets included to the total money that the player is willing to pay. A popped up message appears displaying the current total money whenever a note is selected. To deselect money, player has to click on the money that is on the shopkeeper's hand. Deselected note goes to its previous position and this amount is subtracted from the total amount.

When the button *Give Money* is clicked, at first it is checked whether the total money equals to the price of the selected item. If yes then the item is purchased and shopkeeper's hand glides away the screen taking the money. If not, then the player is asked to give correct amount of money. The shopping completes by exchanging greetings between the player and the shopkeeper (Fig. 1(i)).

Decision making after shopping includes three actions: a) Leave the Shop, b) Visit Another Shop, c) Go Back Home. The total process is depicted in Fig. 2.



(a) Showing a 10 taka note in the tutorial part.



(b) Step 1, a hundred taka note is displayed.



(c) The player is asked to select the five taka note out of four random notes displayed.



(d) Player can either buy or cancel after clicking the chosen item. Here the child is asked to buy an item of 20 taka.



(e) Shopkeeper instructs to pay taka 20 in order to buy the desired item.



(f) The message shows that the player has purchased the item after clicking on the 20 taka note.



(g) Two items have been bought and added to the cart.



(h) Paying the price from different combination of notes in the moneybag.



(i) Exchange of greetings after shopping.

Figure 1: A few screen shots of our game.

4 Experimental Analysis

Our game is very simple and easy to play. We have tested it with the autistic children at Autism Welfare Foundation, Bangladesh and obtained a very positive response from them. There were 4 girls and 5 boys who took part in this experiment. Their age ranged from 9 to 14 years. We divided them into three groups consisting of 3 members each.

The autistic children of group A and group B both had difficulty taking verbal instructions, i.e., they often cannot understand oral communications, but the children in group C did not have such difficulty. To know if traditional approach was helping them to learn about the use of money, we tested them before introducing our game, and the feedback from them was not satisfactory. We observed many

of them had difficulties taking verbal instructions and were picking the wrong money-notes in response to our test. It proves that the traditional approach is not a proper method to teach them about the concept and use of money. Later, in order to compare the performance, we introduced our game to group B and group C students and left the group A students learning in traditional approach. We observed that group B students responded better than group A students after playing our game despite their communication problem.

In traditional manner, the children were shown each type of notes a number of times. Then they were asked to pick a particular note from a set of notes. To teach them the use of money, children were taken to the cafeteria of the institute during lunch time and were encouraged to buy food. This practice often turned out to be vague while shopping

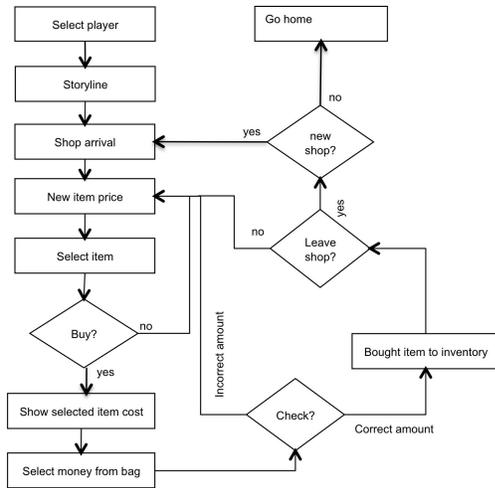


Figure 2: Flow chart of the game.

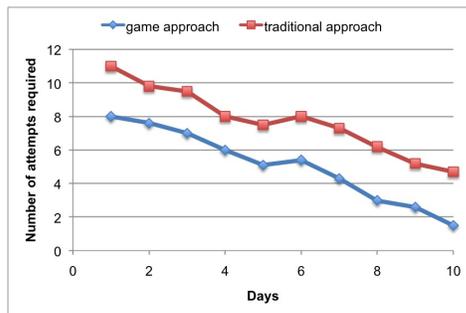


Figure 3: The response of identifying money by the children of Group C.

in general for some children. They get the idea that money can be used only to buy food in the cafeteria but not in other places.

In our game, the children were taught to identify money in the tutorial section first. Different notes were shown to them from different angles a number of times. This tutorial were played as many times as required until they passed the game part of identifying the correct note as was asked. Then they advanced to the next levels respectively according to their competence.

After observing the three groups of children, we found the traditional approach not appropriate for some of the students who had communication problem. They found it difficult to take any instruction and did not response to questions asked to them. Some of them had sensitivity towards touching certain objects. They simply did not seem to be interested to learn about money-notes. Even with students from group C, who did not have communication problem and could recognize verbal instructions correctly, they per-

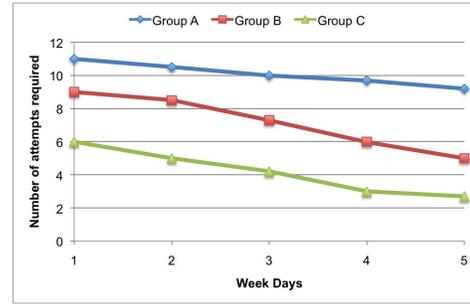


Figure 4: The performance comparison of the autistic children of group A, B and C .

formed much better after they practiced with our game (Fig 3).

Autistic children often have trouble with generalization. This is also true about the concept of money. Most of them cannot understand that they can buy different types of items using the same money. For example, in this particular institute, autistic children of around 11 years old are trained to buy food in cafeteria during lunch. When trained in traditional approach, after some days it is found that the children started thinking of money as a media of buying food only. Some of the children who tend to learn some fixed patterns in order to recognize any object also found it difficult to identify money if asked to pick one in random.

In level-wise testing, it seemed that our game was effective to teach the autistic children to understand the concept of money and its use ensured faster learning than in traditional approach. To make the comparison, we played our game with Group B and Group C children and Group A children were left to be taught in traditional approach. The children played our game five consecutive school days but not in the weekend regularly for a month. However, while measuring performance we noticed the children responded to the game slower than usual on the first day after the weekend but still improvement rate was higher than the traditional approach. Their performance improved as they played the game regularly (Fig. 4).

5 Future Works

We plan to extend our game to further levels in future. We will develop the game to teach the children to calculate the changes in the use of money. In future, we will also address *Impulse Effect* in using the available money and the requirement of proper budgeting skill for the autistic children. We plan to develop games that will teach them more applications with numbers and make mathematics interesting for them. Also, we plan to experiment with more children and with longer times in future.

6 Conclusion

Autism cannot be cured despite today's medical advancements but some practices and therapies can really help an autistic child to mitigate their limitations. Computer games have been proved very powerful in this regard. In our experiment we find that our game, which can also be played along with an instructor, helps the children with autism to visualize the actions to carry out in the shopping mall. The children with autism find it very hard to keep concentration on one topic for long, when trained in traditional methodologies. But when they are visually engaged, they find it amusing and interesting enough to hold their concentration longer and thus it improves their learning skill. We have obtained a very positive response by using digital story-telling technique in their learning process. So in future, we focus on developing more educational games to help them overcome the social, educational, verbal and behavioral problems.

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