Developing a Tablet Computer Game with Visual-Spatial Concept Jigsaw Puzzles for Autistic Children

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Abstract: Autism is considered a Pervasive Developmental Disorder (PDD), which is a severe neuropsychological disorder. For some high-functioning autism or Asperger Syndrome, children may have difficulty with social interaction; however, they may have other unique intelligences, such as remarkable mathematical or visual-spatial ability. Applying the theory of multiple intelligences to this study helps children develop intelligences. Besides, benefits from continuous development of state-of-the-art digital technologies, a jigsaw puzzle game on the tablet computer (pad) was designed and evaluated to aid autistic learning. According to the results, this study is concluded as below: (1) Digital games can help autistic children to develop social skills; (2) the theory of multiple intelligences can be applicable to identify different children's capabilities; (3) Digital assistive technology allows autistic children to concentrate more on the target. Consequently, this study provides a positive sign of considering autistic children's strong capability on rehabilitation, which is an acceptable and feasible approach to help certain groups of children with ASD.

Key words: Autism, Multiple Intelligences, Tablet computer game, Interaction design

1. Introduction

Children with Autistic Spectrum Disorders (ASD) are characterized by three symptoms, repetitive and stereotyped patterns of behavior, impairments in communication and difficulties in social interaction, which can be found around two years old. Most ASD symptoms are found in male with the proportion of 5: 1 (male and female, respectively), and are various with different ages, intelligence quotient (IQ), and order of severity. Autism is a mental disorder characterized by serious isolation, lack of emotion, language disability and repetitive behavior. Therefore, autistic children may have difficulties in daily life to communicate with outside world. They need to be treated with individualized educational therapy to suit the need for recovering their social skills. The treatment could include recovering functional and spontaneous communication during childhood, imitative ability of mother's behavior, ability of functional study, abilities of playing games, maintenance and deduction of natural situation, correction of problematic behavior and instruction of social behavior with same generation [23]. Consequently, educational needs of autistic children include communicative development (verbal and non-verbal communication ability), social development (social skills and adaptability), behavioral development (sensational movement development, repetitive behavior amendment, and athletics, entertainment development) and cognitive development (intelligence and study achievement relevant to the ability development of listening, speaking, reading, writing, mathematics, memory, thinking).

There are several common medical rehabilitations for autistic children. “Applied Behavior Analysis” (ABA) is a conventional way used for years. ABA is a method to set up an individual therapy using educational approach to stimulate children’s behavior to suit different autistic symptoms. “The Floortime Approach” is also a frequently used method to help children with ASD walk out isolative world using gameplay. As many autistic children have sensory disability, “Sensory Integration” can be applied to help patients balance their tactile sense, the vestibule and the substance-related system. These methods mainly attempt to encourage autistic children’s social participation [3, 4, 9, 14, 21]. Among the methods applied to autism rehabilitation, playing game, including behavioral-oriented and developmental-oriented games, is a common way to help ASD children learn social skills. Mastrangelo (2009) indicated that the most important way for autism therapy is to integrate advantage of both to develop “developmental behavioral game therapy” [17]. This could consider individual difference of autistic children and needs for developing social relationship, as well as help children use iterative and constructive learning methods to receive behavioral effects. Autistic Children’s main impairment is they do not participate in playing game spontaneous and keep interacting with partners [26]. Therefore, it is an important goal for game design to interest children.

Professor of Harvard University, Howard Gardner’s “theory of multiple intelligences” (1983) identified eight intelligences of human beings include linguistic, logic-mathematical, musical, spatial, bodily/kinesthetic, interpersonal, intrapersonal and naturalistic [10], and discovered the ninth, existential intelligence in 1999. This theory points out that people are born to have potential of multiple intelligences which appear in different combinations. It also indicated that strong intelligences could waken weak intelligences, so educators should seriously consider difference of children. Human’s intelligence can be improved and developed in proper balance through learning. Although autistic children have disability on their mental development, many of them, particularly for some high-functioning autism (HFA) or Asperger’s syndromes, still have unusual capability, for example, outstanding visual spatial ability [24]. Memory, visual spatial concept, time concept, puzzles, graphic design and music are common in autistic children’s intelligences [25], but they lack of interpersonal intelligence and communication skills, interests on external world, and interaction or verbal contact with people. In view of the fact that previous studies seldom investigate the opportunity of utilizing their inherent distinctive capability on rehabilitation, this study uses some high-functional autistic children’s strong intelligences, such as visual spatial ability, graphic recognition ability, mechanical memory ability and imitating ability to lead to way of improving their weak intelligences.

With the rapid growth of digital technologies, considering how to apply its advantage to the design of assistive technology for rehabilitation has become a critical issue. For children, much computer-aided-learning software was developed to provide various learning experience, which could enhance children’s learning motivation and performance. Under the assistance of game software, children with developmental disorder could follow their own learning pace, release their learning pressure and improve their thinking ability in the game [1]. Hannaford (1983) indicated that using computer in special education have the following advantages, individualization, enhancement of learning motivation and interests, and instant feedback [12].

Computer can provide immediate feedback on individual response and learning progress, accumulate learning achievement and adaptive evaluation to achieve individual learning goal. In general, use of computer technology to help special students may include reading, typing, mathematics, social behavior, thinking instruction, problem solving and iterative practice of teaching material [15, 19]. As the learning ability and development of children

with physical and mental disability may be slower than normal children, computer can provide multi-sensory stimulus, such as colorful display and lively sound, to attract students' attention, enhance learning motivation and performance [16]. Using assistive technology to help students learn effectively is a trend for special education [28]. Computer allows instructors to treat different learners with individual teaching methods, provide individual learning content with proper feedback and interact with students with iterative practice to supplement the disability of special children. Therefore, it is considered as an effective approach to enhance special children's learning [18].

In Taiwan, the Biomedical Technology and Device Research Laboratories of Industrial Technology Research Institute (ITRI) developed a series of rehabilitation game concept using motion-sensing technology, which allow the patient to achieve the goal of rehabilitation using a relaxed way [7]. That is to say, it is identified that traditional boring rehabilitation process could be changed through designers' idea. Therefore, for those children with ASD, incorporate similar concept to develop novel rehabilitation methods based on current state-of-the-art technologies is encouraged. Numbers of studies have been continuously conducted, such as using interactive robot to assist autistic children's communication ability [5, 11, 27], applying digital game to autism learning [2, 6, 13, 22, 29]. These studies provide evidence that digital technologies can be applied to autistic children, who can be benefited by digital tide.

Game plays an important role in Children's stage of development. Children learn through playing games, interact with others and integrate into society. However, autistic children cannot learn social identification through group games and learn basic cognition from games if comparing to same age children. Although children with ASD have social problems, some of them may have strong visual-spatial ability, one that is addressed in the theory of multiple intelligences. Taking this advantage as a starting point, autistic children's concentration could be improved. Additionally, using novel assistive technology and interesting game design, accompanying with user-centered design interface, will attract autistic children to interact with the game and the instructor. This could be a better and more effective way for autism. Therefore, this study takes Gardner's theory, different intelligences co-working, as a basis to investigate the potential of applying tablet computer and designing a digital learning game for autistic rehabilitation. It is expected that this proposal can improve children's concentration and communication behavior. Finally the game was tested by children with ASD to investigate its acceptability and potential in autism rehabilitation.

2. Methods

The research includes three stages works. Firstly, the principles of the game content and interface design were given and reviewed by experts. A fully functioned game prototype was then designed and developed, followed by usability heuristic inspection. The final step is to test the acceptability and potential of the game applied to autism rehabilitation through user testing, i.e., children with ASD and their instructors.

2.1 Pilot work

To inside understand the current autism learning and relative assistive technology design issue, two experts, an autism instructor and an assistive technology expert were interviewed. Both experts have years of experience in their professions and are familiar with special children rehabilitation. The outline of the interview also includes

proposing the game concept, asking for comments on game design scenario, assumed children's responses and any issue concerned to autism rehabilitation. Results of the interview are summarized below.

1. According to children's background, habit and characteristic, the experts suggested that autistic children would have interests on jigsaw puzzle, which could make them stay longer on the game. As children will not pay too much attention on the text, graphical user interface (GUI) is mostly used in computer games rather than text commands.

2. Autistic children may interact with the game based on their previous experiences. Therefore, unexpected feedback may come up with anything displayed. The effectiveness of rehabilitation may differ from cases with different autistic symptoms.

3. Using a flat computer game is feasible for autistic children; however, it should consider the specification of the hardware and children's gesture, which way be different with normal children. The game design should take instructors' companions into consideration to improve communication.

4. The experts suggested the game content should include different levels (spatial cognition difficulty) and sound or light as cues to their moving steps.

5. Applying digital game to medical therapy is a feasible way for children in the future. However, it should consider both instructors and patients, allowing them working together in the rehabilitation process and acquiring encouragement and achievement from the game.

2.2 Prototyping

Based on the design suggestions obtained from experts, this study sets up a series of design references for developing the game prototype.

1. Taking puzzle game with different difficulty levels on spatial cognition as the main content and gameplay will develop autistic children's potential intelligence.

2. Autistic children have imitating behavior, which can be predicted and utilized to design some interface operation.

3. Autistic children mostly rely on visual learning; hence using sound and light effect in the game may draw their attention and enhance their motivation and interests.

4. Accompanying instructors can help children alleviate their anxiety, increase their self-confidence and the opportunity of verbal communication with the instructor.

5. The game takes graphics as main design elements, and texts as supplement.

6. Single or multiple player game modes can be provided to have different learning; single player mode allows the kid to pursue higher level, and multiple player modes enable social behavior.

7. Game scores of different players should be recorded to allow the instructor to understand children's progress.

8. System architecture should be designed to have potential and flexibility of adding more difficulty levels or incorporating different game contents in the future.

This study takes the following autistic children's distinct intelligences as the basis of design concept.

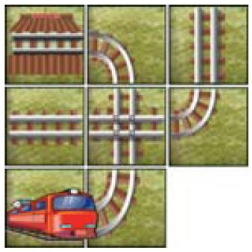
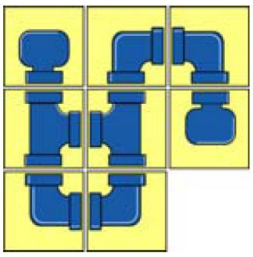
1. Visual-spatial and graphics cognition ability. The game takes logic reaction as the starting point and uses optical illusion concept to design the graphics. It helps to develop autistic children's spatial imagination and logistic thinking.

2. Mechanical memory ability. Although autistic children differ with intelligences, many of them have unique ability such as graphics cognition and memory. Therefore, jigsaw puzzle with spatial graphic design can be used as a potential to their learning.

3. Imitating ability. The most behavior found from autistic children is their imitation on certain motion. If this can be proper utilized or corrected, their abnormal concentration behavior could be improved.

Consequently, three graphics with difficulty of spatial cognition were designed as the contents of 3*3 jigsaw puzzles. Visualized interface, sound and light feedback, instructional imitation animation, difficulty levels and instructors' participation are considered in the game design. Level one (named as Rails) presents in simply two-dimensional gestalt concept graphics. Comparing to level one, logistic complexity are added to level two (named as Pipes) to increase its difficulty of spatial cognition. Level three (named as Snakes) takes three-dimensional graphics with optical illusion design to increase its difficulty (as shown in Table 1).

Table 1. Three levels of game difficulty

Levels	Level 1-Rails	Level 2-Pipes	Level 3-Snakes
Graphics			
Concept	Using route planner to train rationalization of spatial cognition.	Taking non-representational graphic design to train logistic concept.	Applying optical illusion to include spatial cognition, logistic thinking and virtual graphics for advanced training.

The gameplay is set up as Figure 1. Following a step of general game structure, the game allows the instructor to understand children's progress and intervention during the game.

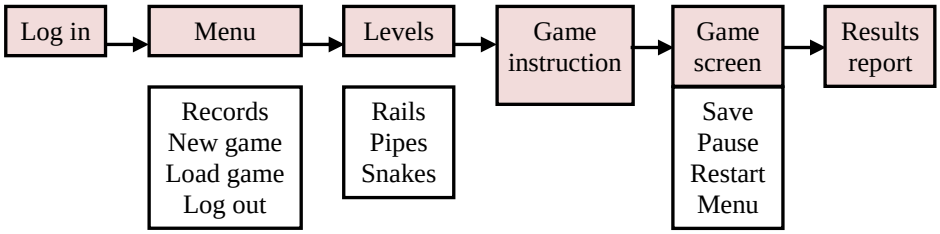


Figure 1. Gameplay structure

The game was designed as the format of Android application and installed in a tablet computer (ViewSonic ViewPad 10S) with 10.1 inches multi-touch screen (1024*600 resolution). The software was developed using Eclipse Java EE IDE, Adobe Photoshop CS5, Adobe Illustrator CS5 and Adobe Flash.

2.3 Usability inspection

As the target user - autistic children are not able to do usability testing of the game interface; this study takes heuristic evaluation to assure the usability of the interface. Heuristic evaluation is a method used to uncover

usability problems through usability experts' perspectives [19]. Hence the game prototype was evaluated by three experienced usability experts, one from academy and two from industry, to inspect system functions and interaction according to usability guidelines. All elements were examined, including graphic user interface, flow, menu, colors, feedback, sensitivity…etc. The problematic interface was then corrected to conform to user's need.

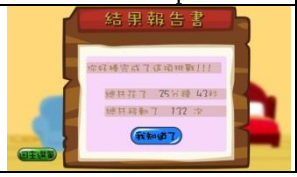
3. Results and Discussion

3.1 Game design

As mentioned previously, this research aims to develop a tool to help autistic children's learning and rehabilitation based on the theory of multiple intelligences, supporting weak intelligences using strong intelligences. The gameplay is a 3*3 jigsaw puzzle tablet computer game with different difficulty of visual-spatial cognition contents. The game design is not digitalizing a jigsaw puzzle game but providing a cooperative learning scenario and rehabilitation mechanism for both autistic children and their instructors (verbal instruction on the step-by-step gameplay and the interaction).

The final game design interface with good usability is as shown in Table 2. The design style of the game uses "Home" as a main theme to make children feel relaxed and play in a comfortable atmosphere. All the touch buttons are designed distinctly and provided with noticeable feedback for any operation. As the game is designed for autistic children in Taiwan, the language used for text is Chinese to support children's recognition. Main functions are described below.

Table 2. The game interface design

Log in	Menu	Levels	Game Instruction
			
Game screen	**Results report**	**Player's records**	
			N/A

1. Log in: When game gets started, background music and welcome information draw children's attention immediately. The accompanying instructor can help the child log in the system using his/her personal game account. The instructor can also create a personal account to examine children's record or progress.

2. Main menu: Main menu includes children's personal records/playing history, starting a new game, loading previous progress and quit/logout to leave the game. Kids can recall their progress if they are willing to continue their previous play. The instructor can easily understand and control children's learning progress.

3. Levels: According to different visual spatial cognition ability, three graphics with different levels can be selected. This will encourage children to challenge step by step to achieve higher level, which will help enhance their motivation, participation and communication with the instructor.

4. Game Instruction: In this page, an animation of moving the jigsaw puzzle sets an example for children to imitate how to play. They can learn through the gameplay and interact with the system.

5. Game screen: A minimized completed graphics is shown to the left of the screen as a demonstration during the game processing. Kids can follow it to move the units of the puzzle to the right position. A board showing elapsed time and the number of moving steps is provided for the kid and instructor to understand the performance. This page allows the player to save, pause, restart or leave the current game.

6. Results report: When the puzzle is completed, a lovely animation appears to encourage children's work and continuing challenge. The completion time and total number of steps are also shown for children and the instructor's reference.

7. Player's records: The record of every single play of individual will be saved to the database of the software. The instructor or doctor can log in to the system to check the records of the children so as to understand individual progress.

3.2 Evaluation

To understand the acceptability and evaluate the potential for rehabilitation learning, the game was tested by autistic children and the instructor. As autistic children vary from symptoms and intelligences, the study takes case study as a method to investigate individual adaptation instead of quantification to understand their performance whilst interacting with the game. Children's behavior was observed and recorded for further analysis to investigate the interaction among the game, children and the instructor.

A special education class of an elementary school in New Taipei City was invited to the experiment. Five students with ASD (all male), including one high-functioning, three medium-functioning autism and one Asperger's syndrome join the evaluation (Table 3). All participants were protected by agreements with their parents and were free to leave the experiment anytime to ensure the research ethics. During the experiment,

Table 3. Participants' background

Case	Gender	Classification	Characteristics
A	male	High-functioning autism	Lacking of patience
B	male	Medium-functioning autism	Patient
C	male	Asperger's syndrome	Used to have unstable emotion, clever
D	male	Medium-functioning autism	Patient
E	male	Medium-functioning autism	Silent and isolated

Figure 2. Children's interaction with the game

The experiment was conducted in a classroom with good illumination without glare from the environment. The tablet computer was placed on students' desk at a visual angel which was comfortable for operation with sitting posture. The experimental tasks include all the game functions and playing the game (Figure 2). Children's operation, gesture, visual navigation, emotion, preference, communication, stability were recorded. The participants were asked to stay with the game for at least 20 minutes to make sure they have already understood the gameplay and tried to sort them out.

The results show that five participants have different operation and multiple feedbacks to the game, including all of the game functions. From the observation, all cases show their curiosity and interests on playing the game. In most situations participants responded to the instructor properly so as to proceed with their plays continuously. It demonstrated that the game, or with the tablet computer, did draw autistic children's attention and stimulate their motivation and communication to explore what happen in the computer game. The main findings of children's behavior are discussed below.

1. All of the participants were able to type and input their usernames using the build-in Android keyboard in the "Log in" homepage and use slide and touch gesture, which means most of the children are capable of practicing basic computer skills, including typing and interacting with the tablet computer. In this study, children used different fingers to tap for primary action or slide to pan, which means that the interface should allow different multi-touch gestures habit.

2. The game keeps most participants stay 20 minutes in front of the desk, except Case A, the high-functioning autism case. The instructor indicated this case used to be impatient. Although he could understand the gameplay and select the most difficult level "Snake" to try to find the solution, he lost patience and gave up after finding he could not accomplish it right away.

3. Only Case D read game instruction carefully at the first time, but he still could not understand the purpose of the game. Although the other cases did not read the instruction, it did not mean they all understand how to play the game so as to play straight away. Therefore, the game instruction would need to be reconsidered in a guided but soft way to allow the autistic children read it willingly.

4. From the observation of participants' behavior, it is clear to see that the cases with high-functioning autism and Asperger's syndrome could understand the gameplay of the game initially; on the contrary, three medium-functioning cases could not. Case B, D and E, they just moved the puzzle squares meaningless and told the instructor that they have accomplished the game after a couple of minutes; however, Case E accomplished the easiest level "Train" successfully after the instructors' help. Additionally, Case C, the Asperger's syndrome, also accomplished all levels of the game without any help.

5. Three different visual-spatial difficulty levels of the game settings did give Case C different challenge and effort to accomplish. In the case of this study, it can be found that certain Asperger's syndrome case does have particular intelligences. The result is in accordance with previous study [23].

6. In total, two cases accomplished at least one level of the game. That is to say, although all cases have no previous experiences on playing similar game, they are able to play the tablet computer game with their own way or even accomplish the game successfully, with or without additional help. This result conforms to that of a previous study [8], autistic children may perform similar ability in playing visual-spatial game comparing to normal children.

7. All of the cases performed positive emotional feedback when interacting with the game; particularly for Case B, who were in very good mood and show high interest to playing the game. Regarding the communication, children were still not able to spontaneously communicate with the instructor to find the way out when they were facing problems; however, they use their curious expression and hesitant motion to show their situation. Incorporating computer as a rehabilitation way for autistic children should be feasible due to their acceptability.

8. Although the cases were able to respond positively to the instructor when they have problems, some of them pushed the instructor's hands away while the instructor were trying to guide them on the screen. Therefore, it can be assumed that if the game can be designed with more cooperative way in the future, it could enhance autistic children more spontaneous interaction with others.

9. Although the game interface was examined by usability experts, few usability problems were still found during the experiment. For example, children were fine with using the alphabet and number keys to type their username, but could not find the "Enter" key on the Android keyboard. The visual design of the virtual keyboard may need to be considered in terms of its legibility for novice children user. Additionally, in the game instruction page, children tried to press the template puzzles instead of the "entering the game" button. This may be due to the gloomy color used, which reduces the visibility of the button.

4. Conclusions

This study takes "multiple intelligences", Howard Gardner's famous theory as a basis to investigate the potential of helping autistic children to utilize their strong intelligences, e.g., visual-spatial intelligence, to enhance their communication and learning using a tablet computer game. The results show that autistic children with different ASD perform differently but positively to the game design, which means the game is acceptable for autistic children and has the potential for rehabilitation. The main findings are described as below:

1. Digital games encourage autistic children's communication

The digital game brings more visual and auditory stimulation and feedback for autistic children. Although it may not be helpful to encourage their verbal communication spontaneously, it increases the interactive opportunity between the children and their outside world, through different communicative forms. The tablet computer game provides novel multi-touched gesture and animated effect for autistic children to explore, which increases their social skills and bridges the children and instructor successfully. However, autistic children have different mental model when interacting with the interface, so the usability issue should be carefully considered.

2. The theory of multiple intelligences can be applicable to autism learning

This research takes autistic children's potential strong intelligences, visual-spatial and graphics cognition ability, mechanical memory ability and imitating ability as the principle to design the jigsaw puzzle game with different difficulties in spatial cognition, logistic thinking and optical illusion. It was found that children with high-functioning autism and Asperger's syndrome can understand the meaning of the graphics, i.e., they do have their own strong intelligence composition. Furthermore, for certain medium-functioning autism, they also have their own ability which can be utilized to enhance other intelligences. Therefore, according to the findings of this study, it is possible to develop adaptive evaluation tool to find out autistic children's individual strong intelligences in the future to enhance autistic children's learning.

3. Digital assistive technology allows autistic children to concentrate on the target

Most autism rehabilitation relies on visual stimulation. The development of digital technologies allows the rehabilitation methods incorporating multiple sensory stimulations to draw autistic children's attention and increase their motivation, even to improve their sensory integration ability. This provides autism rehabilitation more flexibility and convenience comparing to conventional methods. Additionally, novel digital device experience makes autistic children more concentrates on what they are expected to do in a natural way, which could enhance their rehabilitation performance.

Consequently, this study provides a positive sign of considering autistic children's strong capability on rehabilitation, which is an acceptable and valuable approach to help a certain group of children with ASD. As this study contributes knowledge to identifying different interactive behavior with the digital game from observing autistic children with different capability, further work can be focused on developing evaluation tools to have in-depth findings on autistic children with different intelligences.

6. References

[1] Ahmad, W. (2010). Game-based learning courseware for children with learning disabilities. Information Technology (ITSim), 2010 International Symposium in.1-4.

[2] Alqahtani, A., Jaafar, N. & Alfadda, N. (2011). Interactive speech based games for autistic children with Asperger Syndrome. In Proceedings of the 2011 International Conference and Workshop on the Current Trends in Information Technology, CTIT'11, 126-131.

[3] Andaria, E., Duhamela, J.-R., Zallab, T., Herbrechtb, E., Leboyerb, M. & Sirigua, A. (2010). Promoting social behavior with oxytocin in high functioning autism spectrum disorders. Proceedings of the National Academy of Sciences of the United States of America, 107(9), 4389–4394.

[4] Benton, L., Johnson, H., Ashwin, E., Brosnan, M. & Grawemeyer, B. (2012). Developing IDEAS: Supporting children with autism within a participatory design team. In CHI 2012 Proceedings, Austin, Texas, USA. 2599-2608.

[5] Boccanfuso, L. & O'Kane, J. M. (2011). CHARLIE: An adaptive robot design with hand and face tracking for use in autism therapy. International Journal of Social Robot, 3, 337-347

[6] Chang, M. & Kuo, R. (2012). A situated game for autistic children learning activities of daily living. In 2012 Fourth IEEE International Conference On Digital Game And Intelligent Toy Enhanced Learning, 217-220.

[7] Chang, Y. T. (2007). Incorporating happy technologies, rehabilitation can be dancing with joy. Industrial Technology and Information, 191, 16-20. (In Chinese)

[8] Chien, S. Y. (2006). A study on the design of autistic children's toy (Master's thesis). National Taipei Educational University, Taipei. (In Chinese)

[9] Costa, S., Soares, F., Santos, C. & Ferreira, M. J. (2011). An approach to promote social and communication behaviors in children with Autism Spectrum Disorders: Robot based intervention. In Proceedings of 20th IEEE International Symposium on Robot and Human Interactive Communication, Atlanta, GA, USA. 101-106.

[10] Gardner, H. (1983). Frames of mind: The theory of multiple intelligence. New York: Basic Books.

[11] Giannopulua, I. & Pradelb, G. (2012). From child-robot interaction to child-robot-therapist interaction: A case study in autism. Applied Bionics and Biomechanics, 9, 173-179.

[12] Hannaford, A. E. (1983). Microcomputers in special education: Some new opportunities, Some Old Problems. The Computing Teacher, 10(2), 11-17.

[13] Hassan, A. Z., Zahed, B. T., Zohora, F. T., Moosa, J. M., Salam, T., Rahman, Md. M., Ferdous, H. S. & Ahmed, S. I. (2011). Developing the concept of money by interactive computer games for autistic children, In Proceedings of 2011 IEEE International Symposium on Multimedia, 559-564.

[14] Izumaa, K., Matsumotob, K., Camerera, C. F. & Adolphsa, R. (2011). Insensitivity to social reputation in autism. Proceedings of the National Academy of Sciences of the United States of America, 108(42), 17302–17307.

[15] Kao, Y. (1995). Applying computer graphic system to special education. Special Educators Quarterly. 11(1), 1-8. (In Chinese)

[16] Lin, H. M. (2009). A case study of applying computer speech composing system to the training performance of motorcycle written examination for special education students in vocational high school. Special Education Series. Taipei: Psychological Publishing. (In Chinese)

[17] Mastrangelo, S. (2009). Play and the child with Autism Spectrum Disorder: From possibilities to practice. International Journal of play Therapy, 18(1), 13-30.

[18] Meng, Y. J. & Wu, T. K. (2000). A study related affected factors for model of distance assessment and education system in special education. Journal of National Hsin Chu Teachers College, 13, 187-223. (In Chinese)

[19] Nielsen, J. (1993). Usability Engineering. Academic Press LTD, U.K.

[20] Pan, Y. F. (1997). Hope Symphony – Computer aided education and special children cognitive learning. Special Education for the Elementary School, 21, 27-32. (In Chinese)

[21] Robledo, S. J. & Ham-Kucharski, D. (2005). The Autism Book, Answers to Your Most Pressing Questions, New York: Penguin Group.

[22] Sharmin, M. A., Rahman, M. M., Ahmed, S. I., Rahman, M. M. & Ferdous, S. M. (2011). Teaching intelligible speech to the autistic children by interactive computer games. In SAC '11: Proceedings of the 2011 ACM Symposium on Applied Computing.

[23] Tojo, Y. (2002). Exploring the nature of autism education in the 21st century. Research on the Education of students with autistic disorder. National Institute of Special Education. (In Japanese)

[24] Treffert, D. A., & Wallace, G. L. (2002). Islands of Genius. Scientific American, 286(6), 76-87.

[25] Wang, T. Y. & Tsau, C. C. (2002). Knowing the Autism. Kaohsiung: Kaohsiung Autism Foundation. (In Chinese)

[26] Wolfberg , P. J., & Schuler, A. L. (1993). Integrated play groups: A model for promoting the social and cognitive dimensions of play in children with autism. Journal of Autism & Developmental Disorders, 23(3), 467-489.

[27] Wong, A., Tan, Y. K., Tay, A., Wong, A., Limbu, D. K., Dung, T. A., Chua, Y. & Yow, A. P. (2012). A user trial study to understand play behaviors of autistic children using a social robot. In S.S. Ge et al. (Eds.): ICSR 2012, LNAI 7621, 76–85.

[28] Wu, W. T. (1998). Worldwide thinking, localized action - The development and prospect of gifted and talented education. In Special Education Association of the Republic of China (Ed), The 25 Annual Gifted and Talented Education Conference Proceedings, 19-40. (In Chinese)

[29] Yan, F. (2011). A SUNNY DAY: Ann and Ron's world an iPad Application for children with autism. In M. Ma, M. Fradinho Oliveira, J. Madeiras Pereira (Eds.): SGDA 2011, LNCS 6944, 129–138.