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Utilization of Computer Pointing Game for Improving Visual Perception Ability of Children with Severe Intellectual Disability

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Abstract

The purpose of this study is to investigate the effect of computer pointing game on the visual perception ability of children with severe intellectual disability. Based on a literature review, we developed a computer pointing game to improve visual perception ability, which consisted of three stages; catching a hamburger, catching a hamburger and a soda, and catching various foods. At each stage, different instructional models were applied by difficulty level of the contents. Experiments were performed among four children with severe intellectual disabilities for three weeks. They belonged to H public school in Kyeonggi, Korea. Their visual perceptions were quantitatively measured four times by utilizing the Korean Developmental Test of Visual Perception tool (K-DTVP-2). For qualitative evaluation, an observation assessment diary was written and analyzed. All four children at the fourth test showed better visual perception ability, compared with the ability at the first test. As a result of the analysis of the observation assessment, they were considered successful in their learning and ordinary life related to visual perception. It can be concluded that the computer pointing game may play a role in helping children with severe intellectual disabilities improve their visual perception ability.

▸Keyword: Computer Game, Visual Perception Ability, Children with Intellectual Disability

I. Introduction

It is very common for the game generation to experience activities required in their life through games [1][2]. Computer games have been recognized as a useful tool for external motivation, especially for children with intellectual disabilities because they need to be exposed to the learning environment repeatedly [3][4].

Most behaviors in daily life are closely connected with visual perception. Visual perception refers to the process of interpreting and organizing visual information [5]. Visual perception includes understanding what you see, identifying it, judging its importance and linking it to previously stored information. Visual perception also relates to visual memory. It is a necessary prerequisite of initial school learning such as reading, writing, and problem solving. In particular, those with mental disorders show a limited ability in doing tasks related to visual

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perception. The lack of visual perception ability of children with intellectual disability causes critical problem in attention and learning [6][7]. Finally they face troubles in adjusting to society [8][9].

The main flow of research related to visual perception can be divided into three categories; analysis of visual perception development characteristics [10][11], evaluation of effectiveness of program improving visual perception of children with intellectual disability [12][13], and identifying factors related to visual perception [14][15]. However, these studies have the limitations of focus on children with only mild disabilities although severely disabled children are on the increase. Moreover, these lacked the utilization of the computer in improvement of visual perception and instead only compared the traditional paper-based visual perception training with sensory training and art activity. Accordingly, it is necessary for computer-based program to be developed and their effectiveness to be evaluated.

The purpose of this study is to examine whether a computer pointing game can affect the visual perception ability of children with severe and profound intellectual disability. The research question of this study is as follows: can a computer pointing game bring changes in the aspect of visual perception ability (eye-hand coordination skills) of children with intellectual disabilities? This study consists of the following structure; introduction, literature review, method, results, and conclusion.

II. Computer Game, Visual Perception Ability, and Intellectual Disability Education

Individual differences of children with intellectual disabilities need individual instructional strategies. In this aspect, the computer can play an important role in teaching them. Computers can be very useful tools in providing an opportunity to learn problem solving skills by using organized learning strategies for children with intellectual disability [16][17]. According to the result of a study [18], learning with computers can help mentally disabled children improve their eye-hand coordination, which can be a major indicator to express the level of visual perception.

Students with intellectual disabilities have difficulty with concentrating on multiple stimuli with simultaneity because of little selective attention to the learning stimulus, a very short attention span and a narrow range of attention. Intellectual disability is characterized by significantly impaired cognitive function and deficits in two or more adaptive behaviors. Visual perception can be improved through practice. In particular, utilization of computers in educating mentally disabled children can help children with intellectual disabilities participate in learning with pleasure, away from the teacher's one-way training [19][20]. Visual perception includes eye-hand coordination, figure-ground perception, spatial relationship, and form consistency.

Many studies have revealed that computer games can positively influence sensor-motor skill and intelligence by accepting audiovisual stimulus [21][22]. Also, the recognition that experiences with computer games will widely affect the visual perception ability has been expanded [23]. This is why computer games reduce the engagement time of teachers and provide direct and accurate feedback about the student's performance [24][25].

Existing computer-based training programs for treating children with intellectual disability such as COGPACK, REHACOM, LUMOSITY, and Captain's Log have limitations in adapting for severely and profoundly disabled children in the aspect of characteristics of stimulus offered, task level of difficulty, and complexity of instruction [26]. Therefore it is necessary to redesign training programs, which are pertinent to children with severe intellectual disability.

In summary, with regard to the relationship between computer game experience and basic cognitive skills, it can be assumed that visual perception ability can be improved through computer games.

III. Method

1. Participants

We chose four students with intellectual disability who were in a special public school located in Kyeonggi Province, Korea. They had IQ scores below 40 and had no difficulty of eyesight (above 20/30 vision) and manual dexterity. Table 1 shows their basic information. They were not able to do basic skills such as cutting, painting, buttoning up clothes, dressing themselves, using a remote control, and tying shoelaces because of a lack of visual perception ability. 'Koh'

spoke one word of what he wanted to say and could act on instructions. He was inattentive and did not show the ability to do something for himself. Due to repeated training, he could change his shoes, wash hands, and turn off the light. 'Park' with Down Syndrome expressed his intention by laughing and crying. He could not follow the directions because of his low understanding of language. 'Oh' showed similarities with 'Park'. 'Lee' liked to listen and her pronunciation was ambiguous. She was willing to do only what she wanted and was inattentive.

Table 1. Participants' Information

Name	Koh	Park	Oh	Lee
Age (Year)	11.5	10.8	11.2	9.6
Gender	Male	Male	Female	Female
IQ	35	Not measurable	Not measurable	38
Type of Disorder	Intellectual Disability (1st class)			

2. Measures

1) Visual perception

To measure visual perception quantitatively, Korean-Developmental Test of Visual Perception (K-DTVP-2)), which DTVP-2 developed by Hammill, Pearson, & Voress (1993) be translated in korean, was used. K-DTVP-2 consists of 8 sub-categories. Only the hand-eye coordination category with 4 items (score = 184) was selected for the test based on the purpose of this study. The total score of the Test (total number of items=123) is 414. It means that hand-eye coordination is the most important factor among 8 sub-categories of the Test. Specifically, the hand-eye coordination ability was gauged through drawing a straight, curved, and folded line along wide and narrow roads with various methods and connecting the dots without auxiliary lines. The highest score obtained for each question is 2 points, and the final score is the sum of the points of each question. Cronbach's alpha of the hand-eye coordination factor with the 4 items is 0.83 to 0.95, achieving a satisfactory level of reliability [27]. The entire measurement showed a high degree of reliability (Cronbach's alpha = .93 - .99) [28].

2) Observation assessment diary

The study also collected data via the teacher's observation assessment diaries. The contents of diary comprised the teacher's observation and reflection on participants' performance of visual perception-related tasks.

3. Procedure

By utilizing Visual Basic 6.0 and Photoshop 7, we developed a 'computer pointing game' based on the literature review related to intellectual disability and visual perception. Table 2 shows the specific design of 'computer pointing game'. We took two instructional actions for the children's attention and motivation during their utilization of the program: We used pictures of objects that they liked. And we made screen design as simple as possible and gave visual and audio feedback to keep their attention. The experiment was conducted over a period of three weeks (April 5th to 27th). One researcher, who had experience in teaching students with severe intellectual disability for over 10 years, performed the experiment as a teacher. A 15-minute class utilizing the game was given five times a week(total 15 attempts) to four children with intellectual disability. The three-week class consisted of three stages that have different levels of difficulty(catching a hamburger, catching a hamburger and a soda, and catching various foods). At each stage, different instructional models were applied according to the difficulty of the contents. During the first and second weeks, Figure 1 of the instructional model was adopted. At the 'motivating and providing tasks' step, the teacher said "hello" and clapped her hands with a child to the 'clapping hands' song for motivation. Then, she introduced the child to the learning activity of 'Catching a falling hamburger (first stage) and a hamburger and soda (second stage)'. She ordered the child to detach thirty picture cards with images of a hamburger and a soda from the board. The child did the task of catching images of the hamburger and the soda with the speed of 300 pixels (first stage) & 700 pixels (second stage) per second for three minutes on the touch screen of a computer. The child took a rest for one minute and continued the task. The teacher recorded the number of catching images and gave them chocolate as reinforcement.

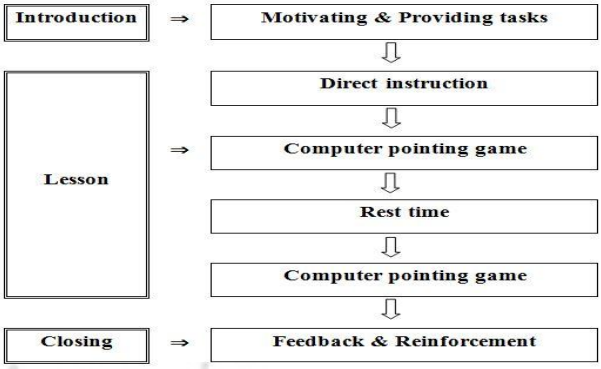

Fig. 1. Instructional Model of 1st & 2nd stages

Table 2. Details for Designing Computer Pointing Game

	Step 1	Step 2	Step 3
Title	Catching hamburger	Catching hamburger & coke	Catching foods
Form Size (pixel)	Height: 10185 Width: 13845	Height: 10185 Width: 13845	Height: 9195 Width: 11715
Frame Size (pixel)	Height: 7815 Width: 11415	Height: 7815 Width: 11415	Height: 6975 Width: 9375
Image Size	3200×3200	2500×2500	1300×1300
Image	Hamburger	Hamburger, Coke	Hamburger, Coke, Chips, Cider, French fries
No. Of Image	3	5	7
Falling velocity (Sec)	0.15	3	0.15~1
Score	Number of pointing and dragging up the falling images	Number of pointing and dragging up the falling images	Number of pointing and dragging up the falling images (basic score: 100, success: +50, failure: −20)
Obstacle	×	×	Putting other images except foods which should be caught by children

During the third week, the teacher adopted Figure 2 as an instructional model. The model reduced the teacher's engagement to the minimum level and increased the child's autonomy in learning. This model was different from the first model in that the lesson is composed of two activities such as setting goals and playing the computer pointing game. The child could change the falling speed for seven kinds of images including a hamburger, a soda, a chocolate chip cookie, and cider. The child did the task of catching them for eight minutes with a speed of 350 to 2650 pixels per second.

Tests of visual perception skills were done four times and each child took the tests on paper. The teacher's diary for observation assessment was written three times (once per week) during the experiment for qualitative evaluation.

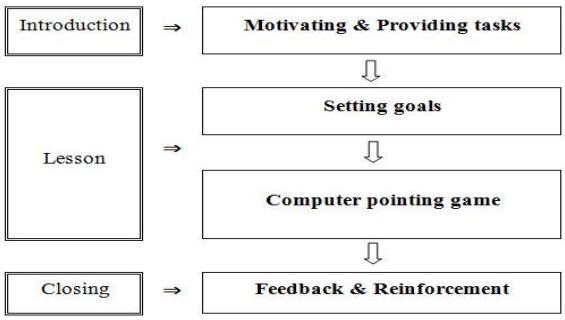

Fig. 2. Instructional Model of 3rd Stage

Fig. 3. Screen of the Experiment

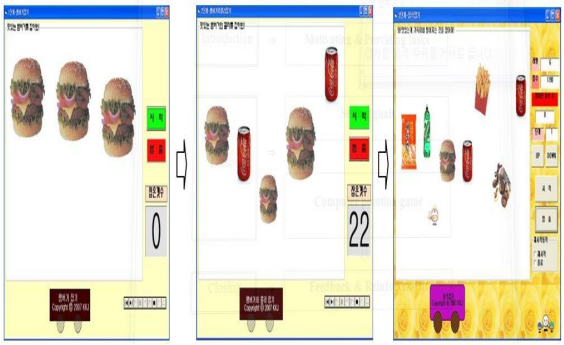

Fig. 4. 3 Stages of the Computer Pointing Game

Ⅳ. Result

In order to identify whether the computer pointing game has an effect on the visual perception of children with intellectual disability, this study analyzed the results of visual perception and observation assessment tests.

1. The Result of Test of Visual Perception

As seen in the Figure 5, 'Koh's eye-hand coordination skill improved steadily. On the first test, he got 15. He grabbed his pen uncomfortably and did not look at the test paper. He took the test through teacher's encouragement. After that, he received a score of 16, 20, and 30 in the second to the fourth test. 'Koh' grabbed his pen comfortably staring with the third test.

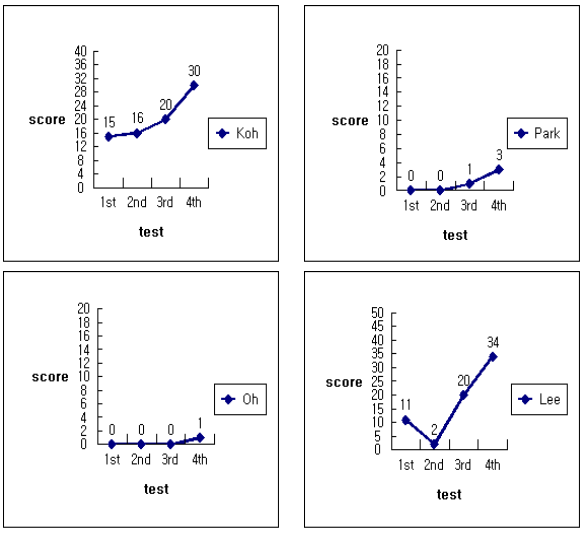

Fig. 5. Quantitative Results of Visual Perception Ability

In case of 'Park' and 'Oh', they were comparatively slow in their performance in the computer pointing game. 'Park' got a score of zero at the first and second tests and a score of one and three in the third and fourth tests. His lack of visual perception ability was reflected in his behavior of crumpling and ripping up his test paper. On the initial test, he did not get a score because he did not response to the test. 'Oh' did not get a score at all until the third test. She got only one point in the final fourth test. She did not pay attention to holding her pen and did not hold her pen tightly. Lee scored lower on the second test than on the first test. At that time Lee had a cold, but after that her skill improved sharply.

2. Qualitative Effect of Computer Pointing Game on Visual Perception Ability

To investigate the qualitative effect of the computer pointing game on visual perception ability, participants' behaviors related to visual perception ability during and after the experiments were described in observation evaluation diaries on a weekly basis. Evaluation written in order to verify the qualitative improvement of visual perception ability of each participant is as follows.

Koh's case

Through repetitive training in the first and second attempt, Koh figured out what the computer pointing game was. At the fifth attempt when the first-week experiment finished, he discovered the method (pointing only one image rapidly) to easily obtain the scores and showed the behavior reducing the accuracy of evaluation. During the first week (from the first attempt to the fifth attempt) the accuracy of pointing increased, and he showed the performance to scribble and hold the pen in a more stable posture in other classes than before implementing computer pointing games. However, after the second attempt when he got accustomed to the computer pointing game, he lost interest in games, and paid less attention to his activity with games as the third and fourth attempt progressed.

Because there was not any training on Saturday and Sunday, at the sixth attempt, the beginning of the second week, he showed curiosity about the new hamburger-soda catching game and pointed out new items calmly. But on the end of the second week, he felt bored with playing the game like the first week, and sometimes he got lower scores compared to initial results of the second week. However, when he conducted the coloring exercise while holding the pen, the line was clear and he had wrist power. Moreover, he exactly put the needle into the holes.

Unlike the adaptation of the computer pointing game at the last (tenth) attempt of the second week, at the beginning of the third week, like the one of the second week, he had a difficult time getting accustomed to playing the game. Moreover, at the third attempt when the activities with the touch pen began, he did not want to grab the touch pen, but on the latter third week, he adapted to the touch pen. However, to keep playing the computer pointing game as holding the touch pen by himself, teacher's continued verbal encouragement was required.

He achieved the goal in each attempt on the first and second week, but on the third week, due to the level of difficulty, he could not obtain the target score. He also could not distinguish between the obstacles and the target objects, and this lowered his scores. However, positive reactions shown in other lessons during the first and second week (from the first attempt to the tenth attempt) also appeared on the third week and other particular changes were not found.

Park's case

Park, who has lower-speed acquisition than Koh, comprehended the contents of activities at the end of the experiment (the first week). He responded properly to the given activities (tearing the picture card off/sitting down and playing the "pointing game"). Pointing at some falling objects in the pointing game occurred intermittently. With the verbal help, he could focus better on the task. The first time he could not tear the picture card off, but managed to complete it during the first week. He demonstrated the potential visual

perception development because he successfully performed the task of putting the removed picture card into the basket in spite of a slow speed. Due to his low-speed acquisition of the targeted skill, it was better to extend the period of the first stage of pointing game, and let him do it perfectly before progressing to the second stage.

The extended first stage was conducted. Influenced by the weekend-break, he showed worse performance than the attempts of the first week. During the attempts that transition into the second stage, he was not successful performing the task. He could not do the exact pointing or pointed at the wrong spot. But the positive reflection of his skill development that showed in the first week also appeared during the second week. He used the fork at lunch-time and he speared the food of pork (around 3 cm in diameter) without help, which was different from his previous performance. At the last attempt (the tenth attempt) during the second week he got the three points, but he still needed more time for progressing into the third stage.

We researchers had a thought about extending the second stage first, but decided to conduct the third stage from the beginning of the third week with Park. However, he had a negative reaction toward pointing with a touch pencil. Instead he was willing to act with fingers by throwing the pencil away. Moreover, he could not distinguish the difference between the foods and the obstacles, and demonstrated behavioral problems such as touching the screen with his palm. Therefore, we returned to the second stage again for the rest of the attempts and requested him to grab the pencil, but he tried to use his fingers intentionally. At other times of his school day, the behavior developed into increasingly pushing things with his fingers (e.g. television on/off button and doorknob). He did not respond properly to the test for visual perception development (drawing the line). His highest score was a three in the third week. This may be because that third week task required more complicated skills of visual perception. However, he did try to draw faint lines grasping the pencil, which was unlike the previous performance during pre-testing in which he did not grip the pencil. The behavior of drawing the faint lines suggested an improvement of his visual perception skills. But, he needs ongoing training via computer pointing games, specifically that of the third stage.

Oh's case

Oh showed similar performance compared to Park. After completing the experiment of the first week, she could figure out the role and process of the computer pointing game. She could not concentrate on the introduction of the game or the activities to tear off the picture cards from the wall, and she could only conduct the performance with teachers' physical assistance. On the other hand, in case of the computer pointing game, she paid attention to the activity with the game and tried to do it by herself. Unlike the previous behavior when she could not do anything without teachers' physical aid in other activities using hands, she stretched her index fingers by herself without teachers' help and was prepared to point the objects on screen. However, after the third attempt, as losing half her interest, she got distracted at the fourth and fifth attempt. In other words, in contrast to Koh's case when he lost his interest at the end of the first week, Oh could not adjust to the computer pointing game, and it was difficult to achieve the goal of the first week. The ability to accurately point the falling objects was improved at the end of the first week (the fourth and fifth attempt) compared to the beginning of the first week (the first and second attempt) that she just put her hands on the falling object lightly.

Like two participants mentioned earlier, Oh also seemed to be unfamiliar with the game at the sixth attempt (the beginning of the second week) due to a two-day break of Saturday and Sunday. Therefore, after conducting the hamburger-catching game (the first step) again at the sixth attempt, she played hamburger-soda catching game (the second step) at the seventh attempt. As attempts on the second week were added, she could not focus on playing the game similar to the first week, and she could conduct the computer pointing game if receiving teachers' verbal assistance. However, she could perform the given task with some physical help through the repeated lesson when conducting the introduction of the game and card-removing task because her hand and fingers got the more powerful. And then, in the other classes, she had an interest in the operational activities such as playing clay and blocks, and took a positive attitude that she tried to do and touch something with her hands without any physical help.

At the beginning of the third week, Oh did not also adapt well to the computer pointing game similar to the beginning of the second week due to the influence of the weekend. She could not easily adjust to the touch pen that was newly introduced in the third week like other participants and tried to keep using her hand to point at the objects. She performed poorly because she could not distinguish between the foods and the obstacles. Moreover, her play in the third week was less accurate than the performance in the first and second

week because the size of falling objects was smaller and falling speed was faster. On the other hand, during the third week, her positive response to the operative activities was maintained and the accuracy of behavior such as a high-five was enhanced.

Lee's case

Lee could not focus on the lesson, and left her seat and went here and there because she paid less attention than the three participants mentioned earlier. On the other hand, her reaction and response to the game was more positive than other participants. Therefore, although she was cautioned verbally from teachers, she actively participated in the overall activities of the class, and easily achieved the goal of the first week. At the fourth and fifth attempt, the last part of the first week, she showed the higher performance ability beyond the established goal and her hand gestures pointing to the falling images were accurate. In addition, she carried activities such as stamping on specific points and connecting hole to hole with thread using the needle.

At the sixth attempt, the beginning of the second week, she also paid less attention than the fifth attempt like the other participants. Therefore, when conducting again the first stage, the hamburger catching game, she got a lower score than the fifth attempt, but after playing the hamburger catching game three or four times, she showed the performance ability close to the fifth attempt. She had an interest in more items on the second stage than the first stage and reached the goal without difficulty at the second week like the first week. On the first stage, she only used her index finger to point the objects, but on the second stage, she got the score exactly by pointing out the objects using the thumb and the little finger at the same time.

The beginning of the third week required time to adjust to the computer pointing game and class because there were no classes on Saturday and Sunday. However, it took a shorter time than the beginning attempts of the second week. She rapidly adjusted to the touch pen compared to the other participants, and it was easy for her to play the game holding the touch pen without any verbal encouragement and physical help. However, adjusting strength was not sophisticated, and more power than is needed was added. On the third stage (the food-catching game), the speed of falling the objects was increased and the size of items was smaller compared to the second stage (the hamburger-soda catching game) and because this required deeper attention, she easily became discouraged. To solve this issue, teachers tried to remind Lee of the goal and to let her achieve the goal using reinforcement, but she ended the game quickly by pushing the exit button controlling the game toward the end of the third week. Moreover, she was often marked down because she had trouble seeing the difference between the obstacles and the target objects like the other participants.

V. Conclusions

This study focused on identifying the effectiveness of a computer pointing game on visual perception, more specifically eye-hand coordination skill for children with severe intellectual disability. We developed one computer pointing game based on related studies and applied it into real instructional environment and analyzed the results. It could be tentatively suggested that the application of a computer pointing game may be helpful in increasing the eye-hand coordination among visual perception skills of children with severe mental disabilities, as evidenced by both improved scores in the skill test and the observed daily task performance. This finding suggests that a computer pointing game can be used as an effective educational tool to promote the visual perception ability. As Sahin and Cimen (2011) suggested, a repeated practice of computer pointing game will promote participants' visual-perception task performance[29]. The finding also confirms their proposition on using more frequent tests during the game application.

The computer pointing game is found as a useful tool to bring out the optimistic change in everyday life and visual-perception-related learning situation for children with severe mental disabilities. This supports the claim by Subrahmanyam and Greenfield(1994) that researchers should examine unintentional learning elicited by computer game-play. In this study, the unintentional improvement of children's skills in lineation, utilization of the fork, and sewing resulting from game play shows that a systematically designed computer game can be an effective educational tool to promote comprehensive visual skill development for children with severe mental disabilities.

The learning of children with severe intellectual disability usually needs the instructor's guidance and help because they lack self-direction. However, even the children with severe mental disabilities who aren't interested in classroom learning can focus on song, images and animation presented by a

computer. In this study, Park and Oh usually do not pay attention to anything without a teacher's guidance, but they paid attention to the touch screen of the computer pointing game. Moreover, they were observed increasingly raising their hands with the intention and performing tasks using the fingers. This finding shows that at a certain point, the children with severe mental disabilities can engage in learning without the teacher's assistance. As such, it can be concluded that the computer pointing game may be effective in improving the visual perception ability of children with severe intellectual disabilities with or without teacher's engagement.

The limitation of this study is as follows. The size of students participating in the experiment was small, although there was the qualitative approach as a complementary measure. So the result of this study needs to be interpreted restrictively.

In future studies, it is recommended that more computer-based content of higher quality for the mentally disabled should be developed and evaluated. An observatory assessment for keeping effects after long periods should be also performed.

REFERENCES

[1] M. Prensky, Digital game-based learning, New York: McGraw-Hill, 2001.

[2] S. Suh, S.W. Kim, N.J. Kim, Effectiveness of MMORPG-based instruction in Elementary English Education in Korea, Journal of Computer Assisted Learning, Vol 26, No 5, pp. 370-378, 2010.

[3] K. Fitros, IT in special education. 2nd National Conference of Educational Technologies, Siros, Greece, 2005.

[4] M. Saridaki, C. Mourlas, Motivating the demotivated classroom: gaming as a motivational medium for students with intellectual disability and their educators. In Felicia, P. (ed.) Handbook of Research on Improving Learning and Motivation Through Educational Games: Multidisciplinary Approaches. IGI Global, Hershey, 2011.

[5] M. Offord, Visual perception disorder. Presented at BLENNZ Teacher Conference, Auckland, September 2007.

[6] A. S. Dolva, W. Coster, M. Lilja, Functional performance in children with Down syndrome, The American journal of occupational therapy, Vol 58, No6, pp.621-629, 2004.

[7] S. S. Hamilton, Evaluation of clumsiness in children, American Family Physician, Vol 66, pp.1435-40, 2002.

[8] Y.M. Yang, The effects of visual-perception training program on attention and learning readiness of mentally retarded children, Unpublished thesis. Changwon National University, 2003.

[9] Y. P. Wuang, W. I. Niew, The effect of adapted physical education program on the outcome of schoolaged children with cerebral palsy, Bulletin of Special Education and Rehabilitation, Vol 14, pp.217-40, 2005.

[10] J. A. Lachance, M. M. Mazzocco, A longitudinal analysis of sex differnces in math and spatial skills in primary school age children, Learning and Individual Differences. Vol 16, pp.195-216, 2006

[11] S. Parush, C. Sharoni, J. Hahn-Markowitz, N. Katz, Perceptual, motor and cognitive performance components of Bedouin children in Israel, Occupational Therapy International, Vol 7, No 4, pp. 216-231, 2000.

[12] F.E. Anderson, Art-centered education and therapy for children with disabilities, Springfield, IL: Charles C. Thomas, 1994.

[13] C. R. White, J. Wallace, L.C. Huffman, Use of drawings to identify thought impairment among students with emotional and behavioral disorders: An exploratory study, Art Therapy, Vol 21, No 4, pp.210-218, 2004.

[14] M. Swanston, Visual perception: An introduction. Psychology Press, 2013.

[15] C. S. Watson, G. R., Kidd, D.G. Honer, P.J. Connell, L. Andrya, D.A Eddins, K. Glenn, D.A. Goss, B.B. Rainey, M.D. Gospel, B.U. Watson, Sensory, Cognitive, and Linguistic Factors in the Early Academic Performance of Elementary School Children; The Benton-IU Project, Journal of Learning Disabilities, Vol 36, No 2, pp.165-107, 2003.

[16] M. G. Brodwin, T. Star, E. Cardoso, Computer assistive technology for people who have disabilities: Computer adaptations and modifications, Journal of Rehabilitation, Vol 70, pp.28-33, 2004

[17] A. W. K. Wong, C.C. Chan, C.W. Li-Tsang, C.S. Lam, Competence of people with intellectual disabilities on using human-computer interface, Research in Developmental Disabilities, Vol 30, pp.107-123, 2009.

[18] C.H. Shih, S.K. Chiu, C.L. Chu, C.T. Shih, Y.K. Liao, C.C. Lin, Assisting people with multiple disabilities improve their computer-pointing efficiency with hand swing through a standard mouse, Research in developmental disabilities, Vol 31, No 2, pp.517-524, 2010.

[19] W. C. Mann, P. Belchior, M.R. Tomita, B.J.Kemp, Computer use by middle-aged and older adults with disabilities, Technology and Disability, Vol 17, pp.1-9, 2005

[20] H. Ritchie, P. Blanck, Promise of the Internet for disability: A study of online services and accessibility of centers

for independent living Web sites, Behavioral Sciences and the Law, Vol 21, pp.5-26, 2003.
[21] T. Kujala, K. Karma, R. Ceponiene, S. Belitz, P. Turkkila, M. Tervaniemi, R. Näätänen, Plastic neural changes and reading improvement caused by audiovisual training in reading-impaired children, Proceedings of the National Academy of Sciences, Vol 98, No 18, pp.10509-10514, 2001.
[22] K. Subrahmanyam, P.M. Greenfield, Effect of video game practice on sptial skills in girls and boys. Special Issue : Effects of interactive entertainment technologies on development, Journal of Applied Developmental Psychology, Vol 15, No 1, pp.13-32, 1994.
[23] E.J. Lee, S.E. Lee, Types of computer game and abilities of children's visual perception, Journal of Children, Vol 24, No 5, pp.43-58, 2003.
[24] T. Y.Liu, Y. L. Chu, Using ubiquitous games in an English listening and speaking course: Impact on learning outcomes and motivation, Computers & Education, Vol 55. No 2, pp.630-643, 2010.
[25] H. Tüzün, M. Yılmaz-Soylu, T. Karakuş, Y. İnal, G. Kızılkaya, The effects of computer games on primary school students' achievement and motivation in geography learning, Computers & Education, Vol 52, No 1, pp.68-77, 2009.
[26] S,N. Kim, Development and application of the computerized cognitive training program for the children with mental retardation, Unpublished Dissertation, Dankook University, 2008.
[27] S.B. Moon, G.W. Yeo, J.T. Jo, Korean - Developmental Test of Visual Perception. Seoul: Hakzisa, 2003.
[28] D. D. Hammill, N. A. Pearson, J.K. Voress, Developmental test of visual perception (2nd ed.), Austin, TX: Pro-Ed, 1993
[29] G.S. Sahin, F.M. Cimen, An interactive attention board: improving the attention of individuals with autism and mental retardation, The Turkish Online Journal of Educational Technology, Vol 10, pp.24-35, 2011.

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