

Training of the Children with Intellectual Disabilities

A Video Based Learning Approach PARITY

Adeela Taleeq, Muhammad Umer Khan, Awais Mumtaz, Tahreem Yasir

*School of Systems and Technology
University of Management and Technology
Lahore, Pakistan*

adeela.choudary@gmail.com, muhammadumer.khan62@gmail.com, awaismumtaz33@gmail.com,
tahreem.yasir@umt.edu.pk

Abstract— this work introduces an animated system PARITY specifically designed to help the children with intellectual disabilities (ID) in order to have an enhanced and engrossing learning process addresses the requirement for coordinating physical activity and social interaction into their lives. This proposed system consists of an animation based training videos, social videos and physical games based on interactive user interface. The videos in this application are designed by considering the mental model of mildly disabled children and their style of interaction and perceiving. The goal of this application is to enhance the cognitive development. Research findings showed that video modeling in teaching the disabled children helps them to acquire skills to greet with the people and training videos were also effective in toilet and feeding training. The results proved that repetitive learning improves their skills form the system specifically designed for disabled children. This automated system had positive effects on the children in terms of cognition and motivational levels. It is very effective system specifically tailored for the children with intellectual disabilities. This paper contributes new insight to design and implementation of video-based environment to facilitate learning and cognition in disabled children.

Keywords—Disabled children, Cognition, Interactive user interface, Learning application, animated system, Intellectual Disability

I. INTRODUCTION

The number of children and youths with disability is increasing day by day [1]. The World Health Organization (WHO) classifies general categories of these kind of children in to mild, severe and moderate [2]. Pakistan with a population of 130.58 million stands seventh among the world's most populous countries. It was estimated that 2.49% of the population is disabled (National Policy for Persons with Disabilities, 2002) [3]. The number of disabled males is greater than disabled females [4]. Personal technologies have transformed, the way we work, stay in touch with our family and friends [5]. We use applications with the best interfaces to spend our free time. For families with the children with the cognitive disabilities, there are not more than one or two assistive applications. The number of children with intellectual disability is increasing dramatically in the whole world. The

world health organization classifies the learning disability into moderate, mild and severe. The degree of learning disability is usually expressed in the terms of the intellectual functioning, psychological activities, the need of special service and behavior [6].

Social skills, physical activities and emotional competence are very important for the disabled children. They have several characteristics which hold back their development [7]. They usually have underdeveloped physical growth, retarded movement, balance and deformation. They have poor memorization, attention, perception, difficulty in speech and poor decision making power. They face a lot of difficulties in social adjustments, basic training and physical activities which cause aggressiveness and bad emotions. These factors make them feel having lower self-esteem. These all factors have a great impact on cognitive development, attention and leaning skills.

Assistive technologies including computer based games, android application and interactive applications have the potential to be helpful in learning of the children with intellectual disabilities. Repetitive learning helps them to communicate, learn and live confidently. Some applications have been developed for few years. A system CC-LR (collaborative complex learning resource) is based on live sessions and collaborative learning [8], [9]. Animated avatars discuss together a topic which is proven to be helpful to train the disabled children. In addition to it, tangible user interfaces have been automated to facilitate parents how to train their children and for children to enhance their learning abilities. A system is developed by using books, toys and mobile digital media. These tools provide an embedded computer chip technology and connect children with the home television and computer through internet. An edutainment system has been developed to overcome the children disabilities from different aspects. It combines Mayer's cognitive multimedia learning approach with Skinner's operand conditioning and involves multimedia incorporating physical activity including edutainment games [10], [11], [18]. After using this system assessment test is being conducted to see the overall performance. The results were very effective. In this work, we

use an android application PARITY with embedded animation based learning model to help children with different types of intellectual disabilities overcome their cognitive challenges. The proposed learning model involves video modeling of some training, social and physical activities of local culture. It is implemented with the interactive animations. It has been developed by using the teaching principles of disabled children. This paper includes all the related work, proposed methodology and detail of the whole animated system. It also includes an assessment test to assess the performance and progress.

II. BACKGROUND

A. Intellectual Disability

Intellectual Disability (ID) is a mental retardation, is classified by below-average intelligence or mental ability and a lack of skills necessary for day-to-day living. People with intellectual disability can do learn new skills, but with repetitively and gradually. Children with intellectual disabilities are Mentally Challenged Children (MCC). There are varying degrees of intellectual disability.

- 1) *Mildly disabled*
- 2) *Severely disabled*
- 3) *Moderately disabled*

B. Learning Models

1) *Mayer's Cognitive Theory of Learning:*

Mayer's theory of cognitive learning [11] allows children to use their auditory and visual challenges in the learning process. It involves long term memory to process multimedia elements in to the mental constructs. This theory assumes the following.

- a) There are two main modules for processing information, one is visual and other is auditory.
- b) Each module has limited capacity of cognitive load.
- c) Filtering, selecting, organizing, and integrating information are the main parts of learning process.

This theory has a proper model of three important processes of cognition. First one is selecting verbal and visual information to yield a learning base. Second involves organizing verbal and visual information to form in to coherent mental representations. The third one includes integrating the result verbal and visual information with one another.

2) *Learning Model Combination with Physical Activity:*

A lot of research has been done on learning with physical activity. Research works have found that repetitive study enhances the learning skills. The results showed that physical activities are effective in cognition. Physical activities [17] also reduce the health risks. Special children don't have much physical activities due to lack of intellectual abilities

3) *Skinner's Behaviorist Operant Conditioning Model:*

This model [18] emboldens social behavior through negative or positive reinforcement. Reinforcement comes in four ways.

- a) Positive reinforcement: Suitable event given to a child after an achievement (praise).

- b) Negative reinforcement: The expulsion of an undesired result after a positive achievement made by a child.
- c) Positive punishment: Unfavorable event is given to the child so as to debilitate the wrong reaction.
- d) Negative punishment: Unfavorable event is removed after undesired behavior is occurred.

III. LITERATURE REVIEW

In today's world researchers of special education have done a lot of work in this field. They are aware to some extent about all the assistive and collaborative technologies that have been developed till yet. References showed that these kind of automated systems have proved beneficial for disabled children in their cognitive development and learning skills. Some references showed that quality of some software's reduces the actual benefits of the systems. Some applications don't provide independent learning.

There are some video modeling systems and animated avatars based which provides live sessions but they don't have embedded videos. Some tools either interact with the computer with input devices which seem to be difficult for some users. The Magic Stick is RFID-based system [19] that aims to help the children to learn the new objects and entities by providing their names associated with their images. The RFID system [20] is used for object identification and is placed on the tip of the stick in order to detect the tags located on different objects. This system was highly appreciated by teachers and parents for its learning benefits; however it didn't help to encourage any physical activity. There are also many expensive educational tools for children that has been commercialized and become popular [22], [23]. Examples are SmarPads [24], Smart Fit Park [25], Wii Balanced Board [26] and Equilibrator [27].

In creating software applications for user with disabilities, it is crucial to follow the guidelines and principles that have been established. User interfaces have string relationship to its demographic of target users and users with intellectual disabilities are target groups that are out of usual. A good user interface designer must be able to attempt to reduce the complexity of software and create a domain, which makes it easy, efficient and enjoyable to use. Based on embedded animation application in Urdu was not developed yet. So this application is easy to use and efficient. It follows all the principles of human computer interaction design. It wouldn't be complex application to use. Our Urdu and English based animated system allows for the replacement of expensive tools with interactive application provides the children with Intellectual Disability an improved learning opportunity by involving their visual and physical activities.

IV. PROPOSED METHODOLOGY

The method is being proposed by learning and cognitive models. It consists of some animations, which includes physical, social and training videos specially designed to suit the mental needs of the children with ID. These videos focus on enhancing the memory skills, social skills and widening

their knowledge have been developed so far. It also includes school activities consist of alphabets learning and paint. This system includes two games. An addition to these, an assessment is also automated to assess the improvement.

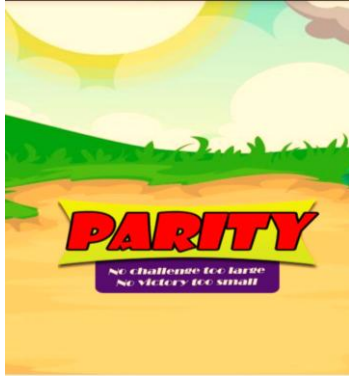


Fig. 1 Main Screen

Videos in the application have three categories includes social, physical and training videos. These videos are specifically animated for children with intellectual disabilities as their parents face difficulties in training and feeding. Physical videos include some local cultural games which will be helpful in their physical activities. They would learn how to play these games after watching these animations. Training videos will suit the need of parents who need to train such kind of challenged children. My school portion consists of English and Urdu alphabets, children would be able to recognize the alphabets come up with the image and a word starts with that alphabet. These images are considered from the children’s local environment. Mathematics numerals are also included in this menu. For amusement, there is a paint menu. Children can draw different things and erase, which is very easy to use and interactive. Apart from it, system contains some games to enhance cognitive skills. The first game targets the children who have difficulties to identify or recognize the objects or numbers. This game is called “Matching game”. In this game children have to identify the image from a set of four different images. An image is displayed on the screen with a set of four different images. The displayed image would have a twin image in the set. The child would then select the twin image to match. The second game is “Memory game”. It needs children to remember the location of matching pairs of pictures among a set of images from different categories. The third game is “Math game”. This game aims at basic arithmetic skills by asking questions that require them to add, subtract or organize number. The application can be customized according to the children’s needs.

These interactive videos and games involve enhancement of their visual and audio skills in the learning process. Children proceed with the three-step cognitive process of selection, organization, identification and integration of the audiovisual information they receive. In order to interact with the tangible user interface of the games, the children will be required to coordinate with the screen. If they play a game correctly they would be awarded with a sound of applause and an encouraging message. If they play a game incorrectly they will

hear a negative buzz implying that it was a wrong answer. And will be given another chance to play. This the mild representation of Skinner’s operant conditioning takes place. This is implemented mostly focused on positive conditioning and encouragement such as the sound of applause and approving message in order to motivate the children. The detailed design of the system is in the following section.

V. SYSTEM DESIGN

A. Video categories

1) Physical videos

Physical videos include local cultural games which enhance the cognition, decision making power and behavioral competence of disabled children. It includes games like Kothla Chipaki, apu stapu and Guriya ki Shadi etc.

Kothla Chipaki is the South-Asian game in which some children sitting in a circle on the floor with their heads down towards the floor. A player with a piece of twisted rope or cloth revolves around the circle made by the children. The player has choice to keep this cloth behind any other children sitting in the circle and all the children look for this cloth behind them. The child with cloth behind him picks up the cloth and he has to beat the former player before he sits in the circle. If he hits him by the cloth then the victim will be out of the game and the number of players becomes reduces and this new player will follow the same process. This game will be helpful in enhancing the decision making power and physical movement abilities. This game is animated in the application which will help the children to learn and will help in physical movement.

Apu-Stapu is also a famous South-Asian game can be played by one or more players. It is a popular game in which players toss a small object into numbered spaces of a pattern of rectangles outlined on the ground and then hop or jump through the spaces to retrieve the object.

The Court:

To play this game, first design a lay out on the ground. Depending upon the available space the court is either scratched out in dirt, or drawn with the chalk on pavement. Designs vary but court is usually composed of a series of linear squares interspersed with blocks of two lateral squares. Traditionally the court ends with a “safe” or “home” base in which the player may turn before completing the reverse trip. The squares are then numbered in sequence in which they’re to be hopped.

Rules:

The first player tosses the marker (ordinarily a stone, coin or bean bag) into the principal square. The marker must land totally inside the assigned square and without touching a line or bobbing out. The player then jumps through the course, avoiding the square with the marker in it. Single squares must be jumped on one foot. For the main single square, either foot might be utilized. One next to the other squares is straddled, with the left foot arriving in the left square, and the right foot arriving in the right square. Discretionary squares checked "Safe", "Home", or "Rest" are impartial squares, and might be

bounced through in any way without punishment. Subsequent to jumping into the "Sheltered", "Home", or "Rest" the player should then pivot and return through the course (square 9, then squares 8 and 7, next square 6 et cetera) on maybe a couple legs relying upon the square until he or she achieves the square with their marker. They then should recover their marker and proceed with the course as expressed without touching a line or venturing into a square with another player's marker. Upon effectively finishing the succession, the player proceeds with the transform by hurling the marker into square number two, and rehashing the example. On the off chance that, while jumping through the court in either course, the player ventures on a line, misses a square, or loses parity, the turn closes. Players start their turns where they last left off. The principal player to finish one course for each numbered square on the court wins. In spite of the fact that the marker is frequently grabbed amid the diversion, truly, in the kid's amusement, the marker was kicked successively back through the course on the arrival trek and after that kicked out. This

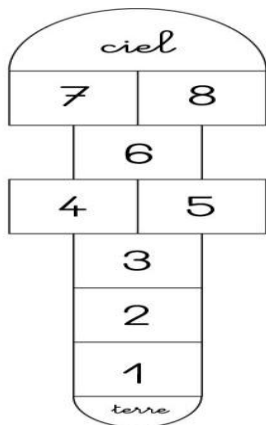


Fig. 2 Example of Apu-Stapu Court

game is very helpful for the disabled children. It also enhances the ability of a disabled child to compete socially.

2) Training Videos

Training videos include the lesson videos to train the children for their toilet service and feeding.

Toilet Training:

Toilet training is a basic aspect of children with intellectual disability and behavioral disorders. The issue of when and how to begin toilet training can be particularly challenging for parents of children with special needs. Parents don't want to push their already challenged child to perform in ways that are impossible. This kind of children finds an insult to their self-esteem. Their level of confidence becomes weak. Their training should be done by proper step and they should be aware of all steps.

Toilet training in the animation is step by step guideline. This kind of children doesn't feel any indication. The character in the animation tries to feel any indication. Then he would need to go to toilet. Kids would learn how to undress him and how to use the toilet. He will learn how to wash himself and steps to wash his hands with soap and water. It would be effective for their training.



Fig. 3 Toilet Training

Feeding Training:

Feeding training is also very important for special children. Disabled and mentally challenged children need a strict training to get feed. Parents of affected children get worry about their basic skills. In feeding training video they will learn to feed.



Fig. 4 Feeding Training

3) Social Video

Guriya ki Shadi (Wedding of Doll):

"Guriya ki Shadi" is a local and social game, which children use to play for amusement. It's sort of traditional game. It's being played by kids has been divided into two families. One family belongs from the female doll and one family belongs to male doll. Whole family of male doll comes to doll home. They organize an event and meal. A lot of guests have been invited. Male doll come with his family to bring her doll to his home after getting marry.

So, this is a social event which has a great impact on children to improve their communication. Children with intellectual disability don't have any social interaction. For the sake of development of their social skills this animations is very effective. Their social interaction becomes better after repetitive watching of this sort of video. They take interest in communication and feel confidence.

B. My School

1) Alphabets:

Alphabets menu contains all English alphabets with words and image. Repetitive learning would help children with intellectual disabilities. Pattern of alphabets is interactive and easy to learn. Interface will seek the attention and interest. This kind of interesting learning will be very helpful in development of learning skills, communication and interaction.

2) Counting:

Counting will be very simple. Pattern of counting is very easy step by step. Number with an image will be displayed. Children will identify the numbers and learn. It will help in mathematics and counting.

3) Paint:

Entertainment is a compulsory part of every child's life. Paint module is added in the system for special children. It's beneficial for these kinds of children with intellectual disabilities.



Fig. 5 My School

C. Games

1) Matching Game:

This game aims at the children who suffer from memory issues regarding concepts and entities they learn in the classroom. The game displays an image on one side and a set of four images on the other side. The child will select the identical image from the set of four images given on the screen on the other side. This allows them to make quick associations with the objects of the images and helps them to enact the cognitive and memorization process. Each time a pair of pictures is correctly identified as a match. Those pictures are highlighted by a dark color around their edges, followed by a sound of applause with an encouraging message.

2) Memory game

Memory game also aims to enhance the memory of the children with ID but in slightly different manner. This game needs the child to remember the pictures. In the first step, a screen displays set four images before starting the first turn. Then in the second step misarranged halves of the four images will be displayed on the screen. Total pictures will be eight initially. Children would have to drag the other half of the image to complete the image. If he gets succeed to join an image, that image will be removed and the screen will display the six images. As they end the game correctly they will be awarded with a round of applause. If they failed to join any image they will keep getting the warning Buzz.

3) Math game:

Math game allows the children with ID to improve their reasoning skills by answering some basic arithmetic questions. It consists of two sub games:

a) Fill in the missing number, by showing nine numbers on the screen within a box. The screen will then present a sequence of four numbers, from one to nine, with one number in the sequence missing. Then children will be asked to fill up the missing the number. Then they will choose the number form the sequence of nine numbers.

b) Addition game, the game starts showing nine numbers within boxes, each labelled with numbers, and the screen will then display a question in the bottom. The sum of the numbers would not exceed than nine. Then children will be asked to answer by touch. They will choose the answer from the random numbers in the screen above.

D. The Evaluation and Assessment methods

The evaluation process for children with ID takes different aspects into consideration in comparison to those for normal children due to their limitation in cognitive capabilities. We have collaborated Amin Maktab School with special needs in Lahore, Pakistan to realize the evaluation experience. We started by introducing the system to instructors of the school. Training sessions were given to familiarize them with the application. Then we chose the participants and classified them according to their background and cognitive state. Instructors helped us in defining measure scales.

1) Participants

The proposed application is tested on a set of 30 students with ID at Amin Maktab School. These children are classified to three main levels of their cognitive disabilities: 1) mildly disabled 2) moderately disabled and 3) severely disabled. The three cognitive levels of the tested students are distributed as: 13 were mildly disabled, 11 were moderately disabled and 6 were severely disabled.

VI. RESULTS

Most of the children were not able to perform well on the Math games, with the exception of some children with mild cognitive disabilities whom were able to solve the math puzzle.

One student from mildly disabled group and two from severely disabled totally refused to participate in the game. Children with severe disabilities were not able to understand the rules of the games or solve any correct answers but enjoyed the games after trying. The child with moderate disability didn't show any signs of motivation an interest.

The relationships of the mental age, timing the coordination and the motivation of students with measured scores were observed.

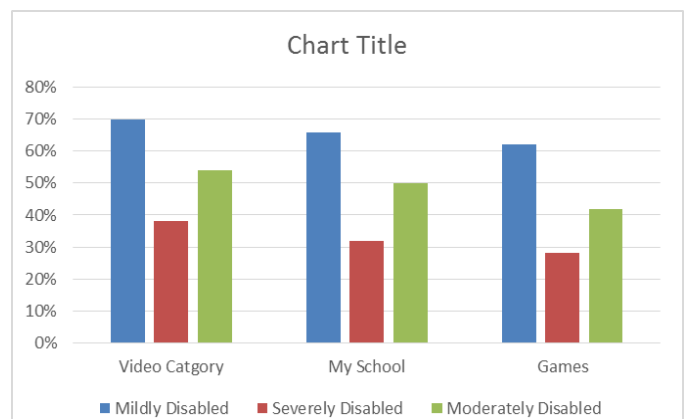


Fig. 6 Results

As the graph shows the clear results, mildly disabled children performed very well in all the categories. Moderately disabled performed well in video categories. In My school menu, their performance was just satisfactory. And the children with severe disability couldn't perform well. But according to results, this application was enough good to train the children with ID.

VII. CONCLUSION AND FUTURE WORK

This system is designed to enhance the learning abilities of the special children. This system will be helpful to the parents and teachers. Videos in the application are the sort of guidelines to the children with the special disabilities. These videos suited the needs of teachers and parents to train their children. A requirement of our clients, the staff of Amin Maktab School has been fulfilled. The training videos incorporate three kinds of categories which are effective for multiple development disabilities. After the training there would be an assessment test to assess the enhancement of the skills. The result of the progress will be shown after the test. General results show that this application helps the children to enhance their cognitive skills. The collected results demonstrate the positive impact for the children's cognitive capabilities in term of scores, coordination, concentration, and communication and memorization skills. The mildly disabled scored 65% score, the moderately disabled scored 47% and severely disabled scored 14% or less than it. So this application supposed to be the best for mildly disabled. We noticed that 70% of the children achieved higher scores after watching the animations, which indicates that practicing the coordination and memorization effects children with intellectual disability and even the severely disabled performed better. We have intended to enhance the effectiveness of the system which will be consisting of more videos to train the children to develop or enhance their motor abilities. The different category of videos can be animated for different kind of intellectual disabilities.

VIII. ACKNOWLEDGEMENT

This research work was made possible by the contribution of Ghazali Foundation and Amin Maktab School. The authors also would like to thank the Amin Maktab School and the directors of special education of Punjab that they made our research meritorious.

IX. REFERENCES

- [1] Disabled World 2013,
- [2] World Health Organization Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks 2009 World Health Organization
- [3] Article%20No.%203_V22_2_12.pdf
- [4] Disability: Situation in Pakistan itacec.org/document/gaw/gaw2014/2.%20Disability%20Pages%202.pdf
- [5] Wu S. K., Lin H.-H., Li Y.-C., Tsai C.-L., Cairney J. Cardiopulmonary fitness and endurance in children with developmental coordination disorder Research in Developmental Disabilities 2010 31 2345-2349 doi:10.1016/j.ridd.2009.09.0182-s2.0-77949268973

- [6] Dawe M. Desperately seeking simplicity: how young adults with cognitive disabilities and their families adopt assistive technologies Proceedings of the SIGCHI Conference on Human Factors in Computing Systems April 2006 Montreal, Canada
- [7] Ould Mohamed A., Sehaba K., Courboulay V., Menard M. Attention analysis in interactive software for children with autism Proceedings of the 8th International ACM SIGACCESS Conference on Computers and Accessibility October 2006 1331-40 doi:10.1145/1168987.11690112-s2.0-34247338955
- [8] Caballé S., Mora N., Feidakis M., Gañán D., Conesa J., Daradoumis T., Prieto J.CC-LR: Providing interactive, challenging and attractive Collaborative Complex Learning Resources Journal of Computer Assisted Learning 2014 30 151-67 doi:10.1111/jcal.120212-s2.0-84892480693
- [9] Nixon H., Hateley E. Books, toys, and tablets: playing and learning in the age of digital media International Handbook of Research on Children's Literacy, Learning, and Culture 2012 2841
- [10] Donnelly J. E., Lambourne K. Classroom-based physical activity, cognition, and academic achievement Preventive Medicine 2011 52 S36-S42 doi:10.1016/j.ypmed.2011.01.0212-s2.0-79958037260
- [11] Mayer R. E. Multimedia Learning 2009 Cambridge, UK Cambridge University Press
- [12] Richardson B., Leydon K., Fernström M., Paradiso J. A.Z-tiles: building blocks for modular, pressure-sensing floorspaces Proceedings of the Conference on Human Factors in Computing Systems (CHI '04) April 2004 1529-1532 doi:10.1145/985921.9861072-s2.0-84876752820
- [13] Black B., Wood A. Utilising information communication technology to assist the education of individuals with Down syndrome Down Syndrome Issues and Information, 2003
- [14] Buckley F. Assisting Individuals with Down Syndrome to Access Information Technology: An Overview 2000 DSE Enterprises
- [15] Karime A., Hossain M. A., El Saddik A., Gueaieb W. A multimedia-driven ambient edutainment system for the young children Proceedings of the 2nd ACM International Workshop on Story Representation, Mechanism and Context (SRMC '08) October 2008 ACM 5763 doi:10.1145/1462014.14620262-s2.0-70349928518
- [16] Lloyd J., Moni K. B., Jobling A. Breaking the hype cycle: using the computer effectively with learners with intellectual disabilities Down Syndrome Research and Practice 2006 9 368-74 doi:10.3104/practice.2962-s2.0-33747860587
- [17] Lund H. H., Klitbo T., Jessen C. Playware technology for physically activating play Artificial Life and Robotics 2005 9 416-174 doi:10.1007/s10015-005-0350-z2-s2.0-31344446120
- [18] Staddon J. E. R., Cerutti D. T. Operant conditioning Annual Review of Psychology 2003 54 115-144 doi:10.1146/annurev.psych.54.101601.1451242-s2.0-0141619496
- [19] Karime A., Hossain M. A., Gueaieb W., El Saddik A. Magic stick: a tangible interface for the edutainment of young children Proceedings of the IEEE International Conference on Multimedia and Expo (ICME '09) July 2009 USA 1338-1341 doi:10.1109/icme.2009.52027502-s2.0-70449598184
- [20] Karime A., Hossain M. A., Rahman A. S. M. M., Gueaieb W., Alja'am J. M., Saddik A. E. RFID-based interactive multimedia system for the children Multimedia Tools and Applications 2012 59 3749-774 doi:10.1007/s11042-011-0768-32-s2.0-84861935690
- [21] Ichida H., Itoh Y., Kitamura Y., Kishino F. Activecube and its 3D applications Proceedings of the IEEE Virtual Reality Conference (VR '04) 2004 Chicago, Ill, USA
- [22] Lee J.-H., Choi E., Song M., Shin B.-S. Dreamware: edutainment system for children with developmental disability Multimedia Tools and Applications 2014 68 2305-319 doi:10.1007/s11042-012-1089-x2-s2.0-84895058321

- [23] Liu M., Rosenblum J. A., Horton L., Kang J. Designing science learning with game-based approaches *Computers in the Schools* 2014;31(1-2):84-102. doi:10.1080/07380569.2014.879776-2.0-84899002437
- [24] Hafidh B., Al Osman H., Karime A., Alja'am J. M., El Saddik A. SmartPads: a plug-N-play configurable tangible user interface *Multimedia Tools and Applications* 2014;72(15):715-30. doi:10.1007/s11042-013-1459-z-2.0-84876182398
- [25] Park S. F. 2006
- [26] Wii Balance Board 2007
- [27] Coxworth B. Linked Wii Balance Boards Help Children Learn Balance Skills 2011 *Gizmag*