Education and Science tedmem

Vol 42 (2017) No 191 109-138

Investigating Interactions between Students with Mild Mental Retardation and Humanoid Robot in Terms of Feedback Types *

Durmuş Özdemir [1], Selçuk Karaman [2]

Abstract

In Turkey and the world, some studies are carried out to support student's cognitive and social development with activities such as robot competitions and robot camps. Additionally, technological materials for robot-aided learning environment have started to become widespread. Robot-aided applications can provide multimedia as well as interactions such as motion, appearance, and touch to the learners. Because of these abilities, robots have an important potential especially for education of mentally retarded students. The studies, in which activities including feedbacks given by humanoid robots are designed and applied, will make contributions to this area for revealing the potential and improving the effective applications like integration of technology into the field of education and the creation of innovative learning environments. The purpose of this study was to examine interactions of students with mild mental retardation in terms of feedback types in the robot-assisted learning environment, analyse participations of students with mild mental retardation in this environment activities and compare the investigation of interactions in terms of feedback types. In this way, it was aimed to create design proposals for feedback types in robot-assisted learning environment to be designed for students with mental disability. Humanoid robot assisted activities prepared according to ASSURE instructional design method. This study was conducted in six sessions on six students with mild mental retardation who were registered in the Guidance and Research Centre (GRC). Being one of the qualitative research methods, case study was used in this study. In the study, data were gathered by carrying out interviews and observations. In order to reach the notions and correlations explaining the data, the methods of content analysis and descriptive analysis were used. In this study, it was observed that the students met the humanoid robot's feedbacks pleasantly and excitedly, they commented and responded amusedly. The use of feedbacks in this study drew the students' attentions and increased

Keywords

Assistive technology

Robot assisted learning in special education

Human-Robot interaction

Robotics in education

Article Info

Received: 10.07.2016

Accepted: 05.04.2017

Online Published: 07.06.2017

DOI: 10.15390/EB.2017.6948

* This paper was generated from the study of doctoral thesis titled "Development of Humanoid Robot and Computer Assisted Learning Environment for Special Education and Investigation Of Interactions in Terms of Feedback Types".

[1] Dumlupınar University, Engineering Faculty, Department of Computer Engineering, Turkey, durmus.ozdemir@dpu.edu.tr

[2] Atatürk University, Kazım Karabekir Faculty of Education, Computer Education and Instructional Technology, Turkey, skaraman@atauni.edu.tr

their motivation. However, there were differences in terms of reaction types in their reactions to the robot's feedback. While feedbacks considered as the most remarkable and interacting by the students were arm, bodily and voice feedbacks, the least responded feedbacks were head movement feedbacks and feedbacks formed through the robot's screen. As a result of interviews made with the teachers, it was specified that humanoid robot make positive contributions to the student motivation and teaching of the lesson. The teachers stated that according to general evaluation forms and the results of their measurements, robot-aided education was useful and helpful at the classroom management, provided quick and permanent learning, and increased motivation and participation of activities.

Introduction

It seems that, individuals having normal development, could usually learn by using existing educational facilities or taking people in their surrounding as model (Rabbitt, Kazdin, & Scassellati; 2015). However, it is known that people with disabilities needed to special education included different concepts and skills with suitable materials for themselves to learn (Povian, Gurza, & Dumitrescu, 2013). Nowadays, widely used materials for students with disability such as audio cards, writing and drawing materials, etc. are mostly behind the technology of our era (Barreto & Benitti, 2012; DeMatthews, Edwards, & Nelson, 2014). Any object, equipment or improved products that improve the functional capacity of persons with disabilities, are directly available to ensure their continuity and development or used as modified are defined as assistive technologies (Braddock, Rizzolo, Thompson, & Bell, 2004; Jonge, Scherer, & Rodger, 2007). In last few years, useful activities related to assistive technologies, which can direct the use of assistive technology in special education, such as tablet computers, smart board applications, laptops, cloud technology applications have taken place (Cejka, Rogers, & Portsmore, 2006; Liu, Wu, & Chen, 2013; Aziz, Aziz, Yusof, & Paul, 2012; Tapus et al., 2012).

Group of mild mental retardation constitutes approximately 85% of people with mental disabilities (World Health Organization, 2011). Students with mild mental retardation learn hardly, forget quickly and have low recall skills (Simons & Dedroog, 2009). They learn abstract terms, concepts, and symbols hardly and slowly. Therefore, concrete concepts or materials should be used (Panek & Jungers, 2008). Their attentions and motivations are very short term (Karal, Kokoç, & Ayyıldız, 2010). It may be required to talk slowly or repeat many times what have been said because their perceptions are lower than their peers (Mirandola, Losito, Ghetti, & Cornoldi, 2014). In this regard, it can be utilized the assistive technology and robots can be utilised to bring up people with mental disabilities as individuals who benefit the personal development, will help to acquire better position in society and will contribute to social life (Bers, Flannery, Kazakoff, & Sullivan, 2014; Berry, Petrin, Gravelle, & Farmer 2011; Valadao et al., 2015).

The purpose of this study was to investigate interactions between students with mild mental retardation and humanoid robot in terms of the feedback types. In accordance with this purpose, activities which are including humanoid robot feedbacks were designed and the reactions of the students to these feedbacks were examined. In addition, it was analyzed whether there were any differences according to the feedback types in the responses they gave and the feedbacks which are effective on the students would be determined. In this way, it was aimed to create design proposals for effective feedback types in robot-aided learning environment to be designed for students with mental disability.

Robotics in Education

The use of robots in the field of education is developing and spreading with each passing day (Fridin, 2014a; Park, Han, Kang, & Shin, 2011; Hung, Chao, Lee, & Chen, 2013). When the studies were examined, it has been observed that the studies on robot-assisted education was generally on storytelling, mathematics, science and language teaching for pre-school and primary school-age students (Barker & Ansorge, 2007; Chang, Lee, Chao, Wang, & Chen, 2010; Hsiao, Chang, Lin, & Hsu, 2012; Keren & Fridin, 2014; Kim et al., 2015). Results of the studies have revealed that robot aided education; supports conceptual thinking, increase student and teachers motivation, make a positive contribution to academic success, enables student-centred learning and facilitate the mental design (Chambers, Carbonaro, & Murray, 2008; Edwards, Edwards, Spence, Harris, & Gambino, 2016; Hyun, Kim, Jang, & Park, 2008; Lieto et al., 2017; White & Robertson, 2015). Also there were some studies indicating that robots facilitate classroom management and allow effective implementation of individual training programs especially in crowded classes (Jormanainen, Zhang, Kinshuk, & Sutinen, 2007; Han, Jo, Jones, & Jo, 2008; Fridin, 2014b).

When the researches were evaluated; it was seen that robots are used in appropriate features activities according to different subject, class and student level and positive contributions are made in terms of factors such as learning, appreciation and entertainments. For example, in the JCLS (Joyful Classroom Learning System) named study, it was stated that robots are able to learn by constructivist approach and also enjoyable (Wei, Hung, Lee, & Chen, 2011). In the study conducted by Han, Lee, Hyun, Kang, and Shin (2009) concerning storytelling in the classroom it was stated that robots' repeating ability had a positive effect on the students' level of listening courses and their likings. In other studies like PEBBLES (Fels & Weiss, 2001) and VGO robot (Bloss, 2011), which are designed for preventing absenteeism of students who do not go to their school because of their illnesses, have been used and observed to be useful. Furthermore, in the literature there are studies that robots have positive contributions to student learning levels and permanent learning in the computer programming education (Akagi et al., 2015; Billard, Calinon, Dillmann, & Schaal, 2008; Hixon, 2007; Rodriguez, Guzman, Berenguel, & Dormido, 2016). Petre and Price (2004) concluded that robot-assisted programming training increased the students' motivation and had a positive effect on their learning thanks to doing realistic and immediate feedback concerning errors. Educational robots were improved the cooperative learning and problem-solving skills in the algorithm and programming courses. (Bers et al., 2014).

Assistive Technologies and Robots Toward Students with Mental Retardation

Various assistive technologies on different types of obstacles are used for students in the field of special education. Although the use of assistive technology robots at different stages of education (secondary education, higher education, etc.) has become widespread, but especially in the mental retardation studies with educational robots is limited (Karal, 2013). When the studies on disability are examined, there are studies for generally physically disabled persons rather than the mentally disabilities, like service robots and physiotherapist robots used in area of medicine (Jafari, Adams, & Tavakoli, 2016). Kakiuchi, Nozawa, Yamazaki, Okada, and Inaba (2009) pointed out that robots were used for helping disabled people especially in changing clothes, cleaning and transporting in the house. Jackson (1993) stated that robots helped mostly individuals with physical disabilities in nutrition, transportation, and medical fields. In recent years, wearable robotic technologies like robotic arms, hands and robotic legs have been used intended for physical disabilities (Huo, Mohammed, Moreno, & Amirat, 2016; Oguntosin, Harwin, Kawamura, Nasuto, & Hayashi, 2015; Park, Santos, Galloway, Goldfield, & Wood, 2014; Rahman et al., 2015).

It is seen that studies conducted on field of technology-supported education for students with mental retardation are especially computer and internet based software (Alessi & Trollip, 2001; Erişen & Çeliköz, 2009; Kuzu, 2007; Yanpar, 2006; Wu, Chen, Yeh, Wang, & Chang, 2014). With the development of new technologies, tablets, laptop computers, smartphones, virtual worlds, agumented reality, cloud technology and game-based applications have been included in assistive technology. With the development of new technologies such as tablets, augmented reality (Abbott, Brown, Evett, & Standen, 2014; Carmien & Wohldman, 2008; Chiang & Jacobs, 2010; Everhart, Alber-Morgan, & Park, 2011; Fernández-López, Rodríguez-Fórtiz, Rodríguez-Almendros, & Martínez-Segura, 2013; Filgueiras, Prietch, & Preti, 2015; Gudanescu, 2010; Lin et al., 2016; Pennington, 2010). These studies have been conducted for students who have learning disabilities and are involved in different categories of mental retardation. Aziz et al. (2012) determined that applications including cloud technology and augmented reality had a positive effect on learning of special education students' who had emotional and behavioural disorders. Campigotto, McEwen, and Demmans Epp (2013) using the application of mobile iOS "myvoice" on special education students aged between 7-12 years in two different areas in Toronto, , they found that students had an increase in attendance to lesson and motivation. Concerning the use of assistive technology in the education of the mentally disabled, Karal et al. (2010) stated that a game giving voice feedbacks and including multimedia objects had a positive effect on development of psychomotor skills of the mentally disabled. In the study conducted by Haksız (2013) on the use of tablet in special education, it was reported that teachers in the application absolutely recommended the use of tablet and it was very advantageous since it is both mobile and has a touch screen. Rezaiyan, Mohammadi, & Fallah (2007) found that games had a positive effect on gathering the attention of mentally disabled.

Shamsuddin et al. (2012)'s study was one of the limited number of research for mentally disabled persons with robot aided learning, they examined the human-robot interaction on students with autism spectrum disorders. They observed the effects of playful behaviour, communication, and socialization. Consequently when compared traditional method, the robot-assisted learning had increased positive interaction and it was successful in attract attention on students with autism spectrum disorders. Investigating the effects on learning of the mentally disabled using Lego robots Lin, Bednarik, Sutinen, and Virnes (2006) reported that in case of procurement of flexible and usable designs, it may be beneficial for students concerning issues such as such as cognitive skills, self-esteem, and spatial intelligence. Robots are used as a tool to gain communication skills with mobile robots in autism therapy. Dautenhahn and Billard (2002) stated that autistic individuals earned simple daily interactions required to establish with people thanks to robot-assisted learning which helped them to develop social skills (Karal, 2013). In a similar study, the robot BEATBOTS was used for therapy of autistic students owing to its dance movements (Kozima, Nakagawa, & Yasuda, 2007). In their study Greczek et al. (2014), used the robot Dragon Boat in children with autism spectrum disorders, who were in need of special education, for a 3-week period. They made a design in order for them to distinguish artificial foods with beneficial foods in practice. Öztürk, Akkan, Büyüksevindik, and Kaplan (2016) indicated their study that, when used virtual manipulators for mildly level handicapped students, they were involved on activities and participated with highly motivated.

Feedback and Robots' Feedback Features

Upon literature review, it is observed that the feedbacks are defined differently. In some definitions, representative aspect of feedback is addressed and who provides feedback is emphasized; on the other hand, some definitions emphasise on the function and purpose of feedback (Narciss et al., 2014; Scheeler & Lee, 2002). There are various opinions about how, when, and by whom feedback is given as well as its format (Lin et al., 2013). Various functions of the feedback such as directing, editing, enhancement, completion, motivation and encouragement may be mentioned (Dökmen, 1982; Özerbaş, 2007; Tekin & Kırcali, 1997). According to Joyce, Weil, and Calhoun (2000) the feedback includes descriptions to individuals about to what extent they learn what they intend, what they should learn further and from which and how they utilise to complete what is missing. According to Hattie and Timperley (2007), feedback is referred as information given by a representative to students regarding the performance or learning. Here the representative may be teachers, peers, books, parents, and students themselves or their experiences". As a short and brief definition Senemoğlu (2010) defined feedback as; "the information is given about learning outcomes".

When examining the literature, there is no classification for the classification of robots' feedback. However, regarding the classification of robots in terms of social interaction aspect, Seifer and Mataric (2005), who are Interaction Laboratory researchers from the University of Southern California, made a classification in their study as follows:

a. Embodiment
b. Emotion
c. Dialog
d. Personality
e. Human-oriented perception
f. User modeling
g. Socially situated learning
h. Intentionality

In the literatüre, "humanoid robots" called that which are capable of exhibiting the specified social interaction characteristics with above (Oztop, Franklin, Chaminade, & Cheng, 2005). Some parts or all of the body produced with analogy of human body, are called humanoid robots (Hackel & Schwope, 2004; Kose, Yorganci, Algan, & Syrdal, 2012). In general, humanoid robots such as "Asimo, Nao, Akıncı" have a head, body, two arms and two basses, and some humanoid robots such as Rollin-Justin, Kompai, Pebbles and iRobiQ which we use in our research are made with only a part of human body model (Bauml et al., 2011; Hyon, Hale, & Cheng, 2007; Piranda et al., 2013). Some of humanoid robots studies for producing facial expressions with only limbs such as mouth and eyes related to robots ability, some of the other similar studies were focused into the specific regions of the human body on mobility, appearance and functions (Fuchs et al., 2009; Pieska, Luimula, Jauhiainen, & Spiz, 2013). "Robots like Saya, Actroid DER-2" are called "android robots" that was designed to be similar to directly human features (Arslan, 2014; Hashimoto, Kato, & Kobayashi, 2011).

Kanda, Hirano, Eaton, and Ishiguro (2004) stated that, they interact to students with the humanoid robot two weeks period, because of the humanoid appearance of the robots students had interested so that using robots supports the language learning. Robots have humanoid appearance so that pre-school students enter into a more comfortable interaction. According to Chang et al. (2010) reported that even though they knew that the used robot was not a real person or human, students accepted robots as authority because of the robots' humanoid appearance and behaviours. Hyun, Yoon, & Son (2010) pointed that, the robot's facial expressions and speech imitation skills was very useful to teachers and thanks to ability of robots again and again speech feature.

In his "Social robot design" study, Breazeal (2003) stated that physical, behavioural, emotional, voice, image and facial expressions of robots should be modelled humanoid form to socialize and their interactions needed to be realistic for human robot interaction. both bodies and facial expressions. In his study Breazeal showed that the method of reading facial expressions from the feelings created at Russell (1997) can be used in robots and he used these expressions on the robot "KISMET". The Saya Robot designed in 2004 can perform basic facial expressions of a man. It can show the six basic facial expressions such as happiness, anger, astonishment, sadness, and disgust (Arslan, 2014; Hashimoto et al., 2011). When considering the limitation of digital media in terms of realism, it is thought that feedbacks given by realistic physical structure of the robot feedbacks will make a positive contribution. It was observed that the aims of feedback in the literature include feedbacks given by a humanoid robot (Lin et al., 2013; Nagata, 1993; Mason & Bruning, 1999; Wang & Wu, 2008).

Students with mild mental retardation when compared to their peers, learn slowly and hardly, forget quickly and have low recall skills (Gözün & Yıkmış, 2004; Türkiye Zihinsel Engelliler Vakfı, 2014). These students need special teaching methods because of their cognitive functions problems, they have learning difficulties in traditional teaching methods different from their peers, so that they need special learning methods with structured according to their individual characteristics (Rezaiyan et al., 2007). When mild mental retarded students carefully examined, their characteristics and needs seems appropriate the above mentioned social interaction advantages of humanoid robot-assisted education. Mayer (2002) stated in multimedia principle that, materials that communicate and interact with learners through multiple sensory organs facilitate learning, motivate learners, design their learning and increase their productivity. Applications in robot-supported learning environments can present different kinds of interactions to learners such as reflection, movement, appearance and integrated multimedia platforms. It is considered robot-assisted learning environment, which allows communication and interaction through multiple sensory organs, has a significant potential especially for education of students with mental retardation. Because of their abilities, it is thought that especially humanoid robots have an important potential for the education of mentally retarded students. As a matter of fact, this situation is supported by the limited number of researches carried out in this area (Dautenhahn & Billard, 2002; Garcia, Brown, Park, & Howard, 2014; Shamsuddin et al., 2012). In this scope, it is important to develop, implement and transform learning experiences supported by humanoid robots into design principles.

It is thought in this study that owing to their above-mentioned advantages, humanoid robots will contribute to education of students with mild mental retardation. The purpose of this study was to examine interactions of students with mild mental retardation in terms of feedback types in the robot-assisted learning environment. In this way, it was aimed to create design proposals for feedback types in robot-assisted learning environment to be designed for students with mental disability. The following research questions guided this study:

a) How did the students with mild mental retardation respond to feedbacks used in the humanoid robot?

b) Are there mild mental retardation students' responses differentiated according to different kinds of feedbacks of the robot.

Method

Due to the limited number of studies and the need to made for the integration of technological studies into the field of special education, it has been thought that, through to the experience of using robot-assisted learning environments in special education, the determination of the recommendations for feedback types of humanoid robots will contribute to the field. According to the research questions given above, it was aimed to create design proposals for feedback types, with the examined interactions of students with mild mental retardation in terms of feedback types in the robot-assisted learning environment. In this section of the study included below topics: Research design, identification of the study group, design model and development platforms and processes, data collection tools, determination of the feedback types, analysis of data.

Research Design

In this study, "Case Study" among Qualitative Research Designs was used. From the McMillan and Schumacher (2010), case study provides to analyse the situation by using in-depth and numerous data sources like observation, interview and document in their own environment. In our study: 1-) The necessity to evaluate different types of activities and feedbacks generated in the robot, to evaluate them with a holistic approach in their creation and use phases 2-) Determination of the effects of the used robot and the generated feedbacks on the students and the environment 3-) Use of different data collection tools in the natural environment at the Guidance and Research Center. For these reasons research was carried out on the basis, Yin's (2009) classification method (multiple case holistic design) was observed to suitable for the study structure.

Identification of the Study Group

The study group of this study consisted of total 6 students with mild mental retardation (3 girls and 3 boys) who were registered in the Directorate of Erzincan Guidance and Research Centre (GRC). Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz, and Demirel (2010) defined purposive sampling method as a probability and non-random method. The students, who were included in the study group, who were involved in group of mild mental retardation in the scale of intelligence of 50-70 according to results of Stanford Binet Intelligence Scale. This measurement has been made at the Erzincan GRC by their staff before our application. Urbano and Hodapp (2011) stated that based on the nature of the study, the sample size could be lower due to the considerable differences between individuals with mental disabilities. Moreover, interviews are conducted with 2 special education experts (with degree of PhD), 3 instructional technology specialists (with degree of PhD), and 2 special education teachers and 2 guidance counsellors in order to determine feedbacks to be used in the robot. The interviewed special education teachers and mentor teachers are those who have 6-12 years of professional experience working in the GRC where the application was made. Information was obtained from these participants about; the students who are planned to included the study group, the curriculum, the traditional application methods previously done with these students and the suggested features that should be founded in the robot. The doctarate special education specialists who are instructors in the department of psychological counseling and guidance department at the university where they are practicing and teaching courses in the field of special education. These specialists had contributed to the study of the robot characteristics and fitness, particularly they informed about robot and the general characteristics of mildly mental retarded students compatible features in teaching activities. The selected 3 instructional tecnology doctorate persons are specialists in the intelligent boards, tablets and computer-assisted instructional design studies. These instructional tecnology specialists were informed us about, the difficulties in their practices, the advantages and disadvantages of the technologies they used, and the suggestion that we could use humanoid robots in our study and the needs for the study group.

Design Model and Development Processes

In the study, the humanoid robot iRobiQ (Yujin Robot, 2015) was used and an instructional software was developed with action script 3.0, simbugger and rocos platforms for feedbacks. The used instructional software and activities for the mentally disabled were designed based on ASSURE instructional design model by selecting subjects from mathematics and social life module according to ZEDEP (2008) educational programme (Heinich, Molenda, & Russell, 1993). The first step of the ASSURE model "Analysis of Learners" phase; determined the students prior knowledge levels and appropriate learning styles from the rough evaluation forms and the interviewed with the field experts and teachers in the GRC. In addition, the study group was determined by appropriate sampling method. Learners were analyzed with their age, class, gender, physical and affective abilities and accessibility of the learners. In the "State Objectives" phase; firstly interviewed the teachers responsible for the students. After concerned and identified the areas where the students in the study group were inadequate and determined the achievement goals from the mathematics module and social life module from ZEDEP (2008). At the phase of "Select Methods, Media and Environments" and "Utilize Media and Materials": according to examined literature, opinions of doctorated academicians in the field of special education and instructional technologies, interviews with the experts and teachers in GRC decided that iRobiQ named robot was suitable for requirements for the study and than procurement process was initiated. Then the activities and feedback types to be used in the robot have been determined. For these goals the activities which was named; four operations activity, object-relation activity, natural numbers activity, nature events activity, learning colors activity and introduce our class activity determined and draft designs maded. In order to prepare the determined activities and feedbacks, researches and applications have been done on action script 3.0, simbugger and rocos platforms. In the design of activities and feedbacks was based on, Gagne (1985) Information Processing Model and Mayer (2002) Multimedia Principles. In addition, Skinner's programmed teaching method was chosen as the instant correction principle in the presented questions by the robot in the events. The sample activity pictures shown on the 7 'screen on the front panel of the robot are presented in Figure 1.

Figure 1. Sample Design View from the Events Given on the Robot's Screen

In the "Evaluate and Revise" and "Require Learner Participation" phase; the working group and the responsible teachers were introduced to the use of the humanoid robot. In order to reduce the effect of innovation, a pilot activity application with pre-event involving 4 operations from the mathematics module was made to the entire working group. The working group was gathered in a class and introduced the features of the robot by starting with "we will meet you with a new friend" and the prepared activity for the pilot application was first showed and explained by the researcher and the students provided to in use the activity. Afterwards students were allowed to freely physically interact with the robot. After the pilot application, it was decided to update the activities and feedbacks in the robot, accordance with the opinions of the special education teacher and the guidance teacher in the application and depended researcher's observations. Especially, activity visuals, some texts and buttons enlarged, the home button's position and color changed and the resolutions of the used icons and images updated. The changes made when the learner given the wrong answer to the feedbacks after pilot application was; the feedback given by the robot as the backward movement ("escape feedback") was shortened and the given robot voiced notifications sort was changed. In addition, changes were made due to the overlap resulting from the "full turn feedback (dance feedback)" and "face feedback" being given at the same time. The studies on the robot feedbacks are discussed with detail given in the following section.

Determination of the feedback types

This study was based on facial feedback classification made by Russell (1997) using human facial expressions. Features of the robot iRobiQ, used in the present study, that supported expressions similar to facial feedbacks used in Breazeal's (2003) study. In studies conducted with iRobiQ, Hyun and Yoon (2009), Hsiao et al. (2012), and Wei et al. (2011) used similar facial expressions. Additionally, Hyun et al. (2010) examined robots in the students' education in terms of mental, social, moral and educational perceptions. As a result of the study, they pointed out that robot contents should certainly contain humanoid emotions (sadness, jubilation, astonished etc.) and also should be used in individualized instruction in classes.

In the study conducted in order to determine the robot iRobiQ's physical feedbacks, simulation of the existing processes in our body language in daily life was made. For this purpose, it was benefited from both Brookhart's (2008) book study "How are your students given an effective feedback?, and Breazeal's (2003) book study "Social Robot Design" as well as studies in the literature. According to Breazeal, instructional feedbacks are any kind of movements made by learners with facial expressions, movability, his head gestures (movements) and other movements of robots in order to reach target. What kind of feedbacks were used in which activities were mentioned and tabulated below. In accordance with data obtained in the literature, feedback types were firstly prepared as a draft. Then, interviews were conducted on using of feedbacks planned with special education experts, instructional technology specialists and teachers. After these interviews, it was concluded that power and effect of feedback would increase with the simultaneously use of feedbacks to be used in robot. The identified feedbacks were tried to be formed as simulation of movements made by a man at the moments when he was happy or sad. Previously created feedbacks were explained below and Table 1.1 shows feedback types used in the robot iRobiQ.

1-) Feedbacks Generated by the Robot's Physical Movement Ability:

(a) The feedback of Robot's full round (Twirling Around): As a result of the interviews, observations and researches, the questions given in the robot activities with the correct answer of the student, then the robot was provided to twirl around itself to show expression of joy. This feedback type was inspired from findings obtained of the interview results. So that it was provided when a happy person turning around him/herself in his one foot as similar as real life.

(b) The feedback of Robot's Dance Movement: As a result of the student's marking or selecting correct answer, second feedback is dance movement with right-left short manoeuvres. The students missed robot's screen and facial expressions in previous feedback "twirling around". For this reason, it was provided that the robot seemed to make a dance movement with right-left short manoeuvres

(c) The feedback of Robot's Escape Back: As a result of the student's marking or selecting wrong answer, the robot was coming back with its wheels. This feedback was considered as embarrassed expression and assumed that students would perceive this movement as a negative statement as a result of interviews made with special education experts. In this feedback, during the pilot study, the students became nervous because they thought the robot was falling off the table, and therefore the return distance was reduced.

2-) Feedbacks Composed with Robot Arm Movements

(a) The feedback of Robot's Arms Up: As a result of the student marked or selected correct answer, the robot's two arms were lifting up and arm leds were open. This feedback was considered as happy expression of robot. It was assumed that the students perceived this movement as a positive statement like movement after a footballer scoring goals. When the student marked or selected the wrong answer, the robot's two arms were lifting down and arm leds were closed for disappointed expression.

(b) The feedback of Robot's Arms Down: When the student marked or selected the wrong answer, the robot's two arms were lifting down and arm leds were closed for disappointed expression.

(c) Feedback of touching the robot arm (Give me Five): According to literature and the interview results with experts, physical touching was more important for students with mental retardation. Therefore, when the student marked or selected correct answer, the robot said "give me five" and the robot was lifting up it's arm. The students were touching with the robot's arm. More attention and relevance was obtained from this feedback type. In this feedback, the student interacted with robot tactile direction.

3-) The feedbacks Composed with Robot's Head

As a result of the student's marking or selecting correct answer, the robot shaked it's head front-back position. When the student selected wrong answer, the robot shaked its head right-left pozition. It is thought that it is similar to the movements that a person makes in real life.

4-) The feedback of Robot's facial expressions

This feedback was formed with red and green leds of the robot's facial area. As a result of the student's marking or selecting correct answer, the facial expressions of robot liked smiling and at wrong answers its facial expression was sad.

5-) The Voice feedback of Robot

Two different types of voice feedbacks were used in robot. First is real human voice such as "Well done, correct answer" or "I'm sorry, wrong answer". Second voice feedback is applause effects and negative community response sound effects, according to the students' answers.

6-) The screen feedbacks of Robot

The iRobiQ robot's 7 inc screen was used to show the student's correct answer symbol "√" or wrong answer symbol "X".

Table 1. The Feedback Types Used in the Robot (IrobiQ)

				A1	A2	A3	A4	A5	A6
Bodily Feedbacks	**Feedback_1**	**Correct**	Twirling Around (full round)	X	X			X	
		Wrong	Escape Back						
	Feedback_2	**Correct**	Dance Movement			X	X		X
		Wrong	Escape Back						
Arm Feedbacks	**Arm Movement**	**Correct**	Two Arms Up+Arm Leds Open			X	X		
		Wrong	Two Arms Down+Arm Leds Closed						
	Touching the robot arm	**Correct**	Give me Five Feedback	X	X			X	
		Wrong	Arm Down						
Head Feedback		**Correct**	Shakes head front&back+Head leds opened			X	X		X
		Wrong	Shaking head right&left+head leds closed						
Facial Expression Feedbacks		**Correct**	Smile expression with face leds	X	X	X	X	X	X
		Wrong	Sad expression with face leds						
Screen Symbol Feedbacks		**Correct**	"√" symbol	X	X				
		Wrong	"X" symbol						
Voice Feedbacks	**Real human voice**	**Correct**	"Well done, correct answer"				X		
		Wrong	"I'm sorry, wrong answer"						
	Acoustic voice	**Correct**	"applause effects"	X	X	X		X	
		Wrong	"community response effects"						

A(X): Activity (X)

Implementation of Application

Application process started with 4 operation activity from mathamatical modul pilot study in order to reduce the effect of the innovation and introduction of humanoid robots. In the pilot application, some changes were made intended for activity designs according to both researcher's observations and special education teacher and guidance counsellor's views in the field of application. These changes were made as upgrading writings and button, changing the position and colour of returning home page button, and increasing the resolution of symbols and images used in applications. Then, the application was implemented with participation of 3 female students and 3 male students with mild mental retardation at total of 6 sessions in the Erzincan Guidance and Research Centre. Prepared 6 different activities which was named with four operation, relations in objects, natural numbers, nature events in air, learning colors and our classromm were used by giving humanoid robot-assisted instruction. During the application process, the teacher, who was working at guidance and research centre, stand by the student. 6 sessions were taken with camera records and also recorded with two different researcher by observation forms.

Data Collection Tools and Analysis of Data

Three different data collection tools as interviews, focus group interviews and observation were used in the study. During the preparation of the data collection tools, the literature was firstly examined by the researchers, after draft interviews and dratft observation forms were prepared. Subsequently, semi-structured interview forms were prepared and updated with 3 doctorate degree academician opinions in the field of educational sciences and special education. The final state of the data collection tools were arranged after the linguist control. It was aimed to using semi-structured forms to intended allow the addition and editing of new topics for feedback and activities that are generated by participants' views during the interview process (McMillan & Schumacher, 2010).

The first interview was conducted semi-structured forms with 2 special education teachers, 2 guidance teachers and administrators in GRC about including questions on the determination of the working group and needs, the analysis of the environment, the determination of target achievements and efficiency topics. After the first interview, the subjects of ZEDEP’s (2008) mathematics and social modules were determined and the students who were planned to take part in the study group were pre-determined. After this process, 2 academicians with special education doctors were interviewed with semi-structured form including questions on draft activity plans, working group preliminary knowledge, target gains, robot selection and determination of feedbacks to be found in robot. After the interview; the robot requirements features were determined which must be included that have a human-like qualities (face, head, arm, voice, etc.) and a screen that they can touch, especially with mathematical manipulation of visual content, to achieve target achievements. Subsequently, preliminary interviews were completed with focus group discussions to determine draft events, feedbacks, supply robot and the desired quality activities with the 3 expert in the field of instructional technology, who are involved in the integration of technology on mental disabilities. In this way, it was decided to work with the named iRobiQ robot and prepared the activities which are integrated to robot then pilot design application process was started.

After the pilot application and 6 sessions of activity applications had an interview with semi-structured interview forms on special education teachers and guidance teachers who participated in the application. Because of to determine for to feedback types effect and activity effect on students which was attended to activities. The following operations were carried out with the results obtained from the interview and the data obtained after the pilot study. “Escape Back” feedback was shortened because of the student's irritated. In addition, the order of the "applause voice and correct response" feedbacks given by the robot as voice feedback was changed and conflicts were eliminated. It is possible to see the face of the robot by using the "dance motion feedback" due to the overlap resulting from "full turn" and "face feedback" being given at the same time. As a result of these adjustments, 6 sessions of activity applications were carried out and rough evaluation forms in GRC at the end of the activities were applied on the students participating in robot-assisted activities by the teachers. In this way, measurements were made about the learning levels of the students and interviews were made with the teachers about their situation.

For the observations used in the research; two different observation forms were created by the opinions of the special education experts and the rough evaluation forms used by the teachers in RAM in the traditional way and used in their lessons. The first form is a semi-structured observation form which is a class observation form prepared to take note of the reactions and behaviors of the students to the feedback of the robot in the activity applications. The second form was used for analysis of the video recordings about the information gained in the classroom to verify, compare, and if there was a missed situation during the observation. This form, which is in unstructured format was used by two different researchers and on this way the researchers noted all the remarkable cases that occurred. At this time, there was also a check of the reliability between the observers.

Analysis process was done under data and video recordings obtained from forms in line with observations and interviews. Interviews were taken voice recordings and taken notes to forms with permission from the participants. The methods of content analysis and descriptive analysis were used in the analysis phase. The interviews conducted before and after the application were made by the 1st researcher. In order to ensure consistency and reliability control during observation and video recordings analysis, the 1st researcher and 2nd researcher worked together on evaluation, review and analysis stages of the video recordings during the application.

Descriptive analysis was carried out in order to determine and clarify the responses given by the students to the types of "Bodily Feedbacks", "Arm Feedbacks", "Head Feedbacks", "Face Expression Feedbacks", "Screen Feedbacks" and "Voice Feedbacks" generated in the robot and the results were presented in the heading of findings. During the analysis of observation data, students' reactions to robot feedback and their subsequent behavior were analyzed. In preliminary analyzes; behaviors were determined and analyzes were conducted according to these codes. Student's hands pointing with the robot's hand movements, pointing to the feedback after the correct answer, establishing eye contact with the teacher through sharing his or her success, taking his hands to his mouth, touching to robots, trying to shake hands with robot, applauding to the robot, responses to robots feedbacks. That is, the focus of consideration in the analysis of student reactions has been the behavior of students after feedback. Through these behaviors, it has been found out that the students are liked, excited, realized and reacted.

Content analysis was used to compare student responses according to robot feedback types and to determine the impact of feedback on students level. At this stage, the video recordings evaluated by structured observation forms were subjected to content analysis by the 1st researcher, 2nd researcher and expert in the field of special education. As a result of the analysis, the differences in the students' responses appeared in the following terms: "notice feedback", "reaction to feedback" and "willing participation and like feedback". The formation of each theme is based on the categories categorized below. "Notice feedback theme": students points with hand movements to robots feedback, touch of the students with the physical feedback of the robot, when the wrong answer feedback given student became sadness. "Student Reaction to feedback theme": After the feedback student's taken hands to his mouth and lifting up, loudly and sadly with a high voice, establishing eye contact with the application teacher after sharing the success of the correct answer mark. "Willing participation and like feedback theme": Applauding the robot by the student, The cheerful and willing smile of the student, The student trying to shake and joke the robot. In order to determine the student response levels, the video recordings were re-evaluated and the responses under each theme (0 = none, 1 = few, 2 = medium, 3 = many) were scored. In this way, students' reactions can be compared according to feedback types. The responses of the students according to the robot feedbacks were scored by the researchers. Averages of these scores were taken and the students' awareness of robot feedbacks were determined. In this way, student responses are compared according to feedback types used in robot and presented under the heading of findings.

Results

The results of the analyzes are presented in two different sections as "Reactions of Students to Robotic Feedbacks" and "Comparison of Student Responses to Robotic Feedback Types" within the scope of research questions.

A) Reactions of Students to Robotic Feedbacks

Findings of robot feedbacks generated by analysis of observations and interview data are presented in the order given in Figure 2. The responses of the students to the feedbacks have been analyzed through descriptive analysis. Below is a sample screen display of student behaviors according to feedback types. Behaviors such as pointing the students with hand movements and feedback, sharing the success after the correct answer with the teacher and setting up eye contact, taking a smile, taking their hands to their mouth, touching robots, trying to shake hands with robots, applauding to robot and loud pleasing phrases are categorized in related feedback types presented in the context of findings regarding student behaviors.

1-) Bodily Feedbacks

- (a) *The feedback of Robot's full round (Twirling Around):*
- (b) *The feedback of Robot's Dance Movement:*
- (c) *The feedback of Robot's Escape Back:*

2-) Feedbacks Composed with Robot Arm Movements

- *(a) The feedback of Robot's Arms Up and Down:*
- *(b) Feedback of touching the robot arm (Give me Five)*

3-) The feedbacks Composed with Robot's Head

- *Robot shaked head front-back pozition (Approval feedback)*
- *Robot shaked head left-right pozition Sola Sallama (Wrong answer feedback)*

4-) The feedback of Robot's facial expressions:

- *Smiled face expressions and sadness face expressions*

5-) The screen feedbacks of Robot:

- *Smiled image of the robot and "X" mark*

6-) The Voice feedback of Robot:

- *Human Voice (Weld done, true answer and Sorry, wrong answer)*
- *Effect Sound (Applause and Community negative "Aaaa" sound)*

Figure 2. Presentation Order of Findings for Robot Feedback

1-) Findings About Feedbacks Formed by the Ability of the Robot's Bodily Movements

(a) The Students' Responses to the Full Round Feedback (Twirling Around)

When the students gave correct answers to questions at the activity in this feedback, robot turned its full round and made jubilation motion. The students understood robot's full round and jubilation motion. It was observed that they perceived this situation as a result of giving correct answer. Figure 3 shows sample image given intended for jubilation observed at the student' facial expression.

Figure 3. Robot's Full Round (Twirling Around)

(b) Students' responses to the feedback of dance movement

In this feedback, the robot gave jubilation feedback in the form of a dance movement with right-left short manoeuvres. The students noticed this feedback and they were happy and understood that their answer was correct as a result of dancing of the robot. When this feedback was compared to the previous feedback (full round), the most important advantage was that the students could see facial expressions of the robot. Figure 4 shows an image of this feedback given from the application stage.

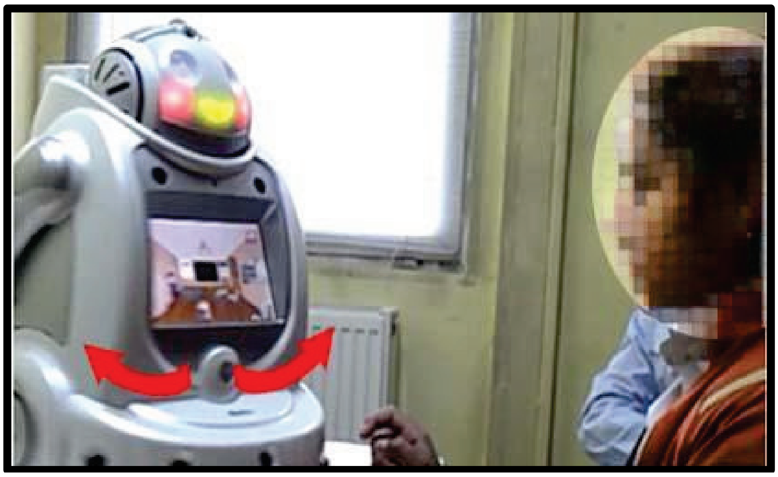

Figure 4. Right-left short rotation movement at the correct answer

According to teachers' opinions about the right- left dance movement feedback, the students did not miss robot's feedback in its face and screen and this situation was more advantageous compared to robot's full round. However, they specified that this feedback was not effective as much as the robot's full round. Example teacher statements regarding this condition are as follows;

> *"My students missed some expressions on the robot's face and screen at robot's full round. This situation eliminated in the dance movements. The fact that robot gives human responses such as dancing has enabled the children to accept robot almost as teacher." (Special Education Teacher 2)*

(c) Students' responses to Back-to-Forward movement (Escape Back) Feedback

In back-to-forward movement feedback, the findings observed in students are as follows: When the students gave wrong answer, thanks to this feedback they understood what they did wrong. For example (Student 3) verbally expressed as "Aaa I have just done it wrong again!". Even some students (Student 1 and Student 6) showed expression of embarrassment by taking their hands to their faces when they gave wrong answer at the negative feedback. Additionally, (Student 4) got stressed and used harsh statements after third trials to find out correct answer. This situation is asserted as indicator of the student's perceiving the robot within natural process of daily life. It was observed that some students tried to hold the robot at the robot's back-to forward movement since it went back as if it would fall off the table. After this occurred in A1, backward distance of the robot was shortened and occurrence of such a situation was prevented. Figure 5 shows an image of sample student behaviour related to this situation.

Figure 5. Students wanting to hold back movement of the robot

The teachers specified that distance of back movement of the robot made some students get into the panic but the situation improved after the shortening process. It was reached the result that this feedback was assessed as effective by the teachers. Examples of teacher statements are given below regarding back-forward body movement feedback.

> *"Some of the children were panic a little bit when the robot went back. After shortening the distance of back movement, it improved but a different negative feedback may be done." (Special Education Teacher 1)*

2-) Findings about feedbacks composed by robot arm movements:

(a) The Students' responses to robot's double arm up-down movement feedback

There was no contact of the robot's arm in this feedback. In this feedback both arms lifted up in case of the student's correct answer; whereas, both arms were down in case of the student's wrong answer. While the students responded with appreciation and smile to the robot's correct answer feedback, they made sorry movements to the robot's wrong answer feedback. Figure 6 and Figure 7 show the students' example responses given robot's feedbacks.

Figure 6. At the correct answer, robot's "jubilation with both arms up" feedback

As shown in Figure 6, the student perceived and smiled robot jubilation motions after his correct answer. The teachers said that "both two arms down movement" feedback was very impressive, specified that students noticed the feedback and resembled a real person's sadness behaviour. On the other hand, after the student gave wrong answer, she took her hands to her mouth as a result of understanding robot's sorry expression in Figure 7.

Figure 7. At the wrong answer "both arms down (sorry)" feedback

Examples of teachers' opinions are given below.

"Arm movements are certainly very effective for the students. We see student's feelings in their direct responses." (Special Education Teacher 2)

"I think these movements of the robot resemble a human being exulted or worried in our daily life, therefore, the children noticed it."(Guidance Counsellor 1)

(b) Give me five (Touching the robot arm)

In this type of feedback emerging as a result of the student's contact with the robot's arm, it was observed that all students in the study group responded by showing a feeling of appreciation and excitement. It was observed that the students took their hands on their faces due to joy and made positive responses and comments verbally. Examples of responses indicating these feelings of the students are given below. These examples showed that the students could establish "effective communication or interaction" (theme1) with humanoid robot.

"My teacher it says me give me five" <smiling> (student 2)

"I'm so excited" <happily> (student 6)

"I slap your hand my friend" <laugh loudly> (student 3)

"Now you give me five" <smiling> said to robot (student 1)

Figure 8 shows an example of interaction established by the students through contact with the robot's arm when the students gave correct answer.

Figure 8. After "give me five" feedback, the student interacted with robot's arm

The teachers specified that the students liked "give me five feedback" and this feedback took attention of the students. Also they specified that the students tried to find out correct answer to interact with robot. Example statements from teachers' opinions about this subject are as follows.

"They liked especially feedback of give me five at most (Guidance Counsellor 1)

"My students loved the form of human response <Give me five> and they focused on finding correct answer to do this movement with robot." (Special Education Teacher 1)

3-) Students' responses to the robot's head feedbacks

Head feedbacks are feedback type formed with the help of head movements of the robot. In the students' right answers robot approved with shaking movement (front-back); whereas in the students' wrong answers robot gave humanoid feedback by indicating that answer was wrong with head shaking movement (right-left).

When the students' responses to this feedback were evaluated, the least remarkable type of feedback in the robot was observed to be head feedbacks. Because only one of the students (student 2) noticed the head movement. It could be asserted that this feedback was very week compared to the other feedbacks. The teacher's statement supporting this situation is as follows;

"My students did not notice front-back and right-left head movements. Because the body and arm feedbacks of the robot suppressed this feedback. It may have even caused by the size of the robot's head." (Special Education teacher 1)

4-) Students' responses to Robot's facial feedback

One of feedback types offered to the students is also type of feedback generated by the robot's facial expressions. Feedbacks of "happy" and "sad" human emotions were given with the help of LEDs in the robot's face. It was stated that the students' first interaction with the robot was in the form of looking at the robot's face. One of the important results of the study was that all of the students had the eye contact by looking at robot's face. Figure 9 shows images that all students included in the study group focused on the face of the robot.

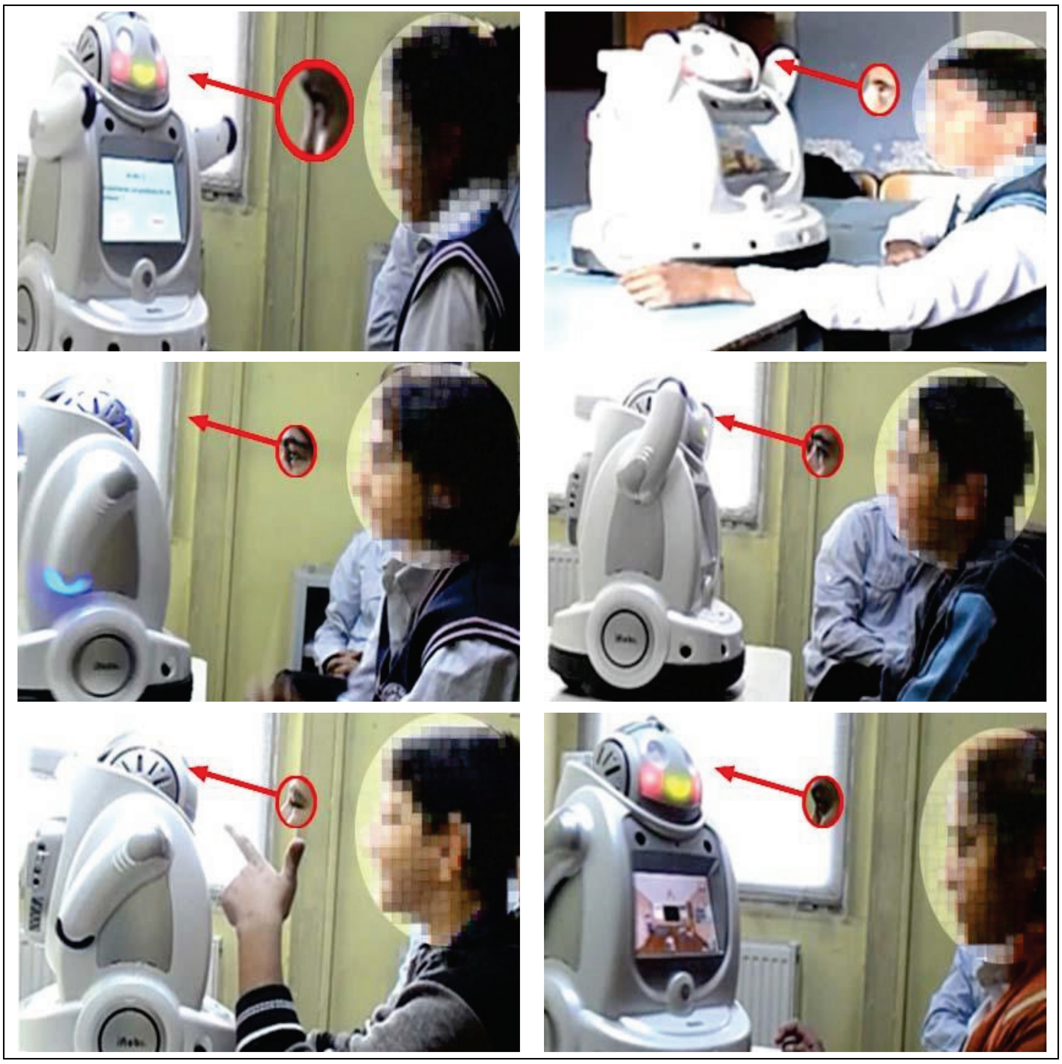

Figure 9. Sample moments of students' focusing on the robot's facial expressions

Especially in activities of A3, A4 and A6 in which full round movement was not involved, it was observed that all the students focused on the robot's face. However only two students (student 1 and student 2) noticed the heart symbol in the robot's eye expressions. It was observed that the students perceived the expression on the cheeks of robots used in face feedback and made interpretation about this. For example (student 2) specified "checks are reddening" in Activity 4(A4), Figure 10 shows sample image showing the comment of the student.

Figure 10. When student was making comments about robot's facial expression to the teacher

Besides, the students noticed the laugh and sad feedback generated by LEDs around the mouth of the robot. It was also observed that they smiled or pouted. Example of the teachers' statements on this subject are as follows.

> *"My students noticed mouth and cheeks on face feedbacks, but did not see hearts in the robot's eye. However, I am not mistaken some of students for example (student 2) said "hearts are appearing in its eyes"." (Special Education Teacher 1)*

5-) Students' responses to the robot's screen feedbacks

At the correct answer "the smiley picture and sign √" were used together, and in the students' wrong answers, red "X" symbol was used. The analysis of the observation records made in application revealed that the students looked at the robot's screen but there was no response or comment regarding this feedback. It was observed that the students used the robot's screen only to answer questions and watch animations. In the mean time, after problem of marking on the screen, only two students gave expression as "my teacher, it seems not click".

The teachers stated two situations for why the students remained unresponsive to screen feedback and they did not draw their attentions. They were of the opinion that firstly, simultaneously given other feedbacks were more attention grabbing and dominant and the other reason could be small screen of the robot.

6-) Students' responses to the robot's voice feedback

Voice feedback was used in two different structures in robot. In the first structure, by using a real human voice " well done right answer," at the right answer and "sorry wrong answer" at the wrong answer were used. In the second structure, "applause effect" at the right answer and " Aaa community sound effect" at the wrong answer took place.

Both feedbacks used in voice feedback structure were understood by the students, attracted their attention and they interacted with robot. For example, in the feedback given with real human voice used in A4 (student 4) responded " I am sorry too" against to the robot's feedback "sorry, wrong answer". After feedback formed with the help of effects, it was observed that the student hearing the applause sound made himself applauded. Figure 11 shows the student's applauding image.

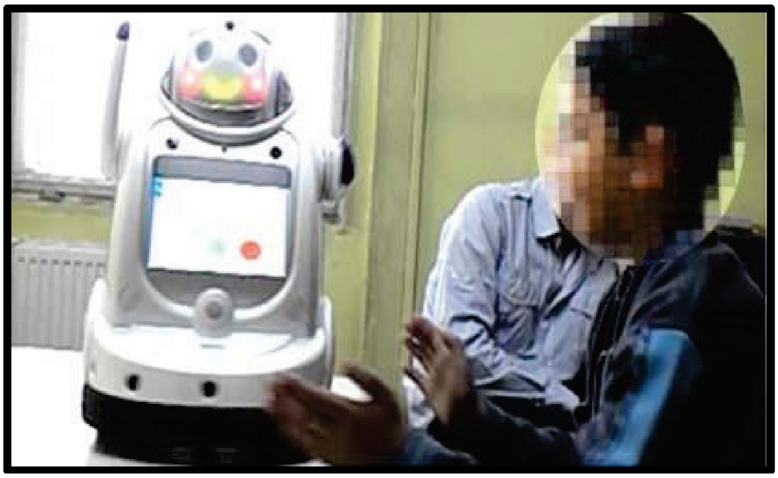

Figure 11. (Student 4) said clap me and danced when he knew correct answer

The teachers emphasised that giving constant feedback at the same level of consistency and sound by robots is important to attract the students' attention. Example teacher statement is presented below regarding the advantages of voice feedbacks and for their effect in the classroom.

> *"If I give examples, I constantly tried to explain by drawing the pictures and shapes on the blackboard while teaching the topic of natural events. In robot-assisted education, voice responses of the robot and its sounds like lightning enabled them to focus on incident I want to teach since they saw and listened the incident in a realistic way and they learned easily" (Special Education Teacher 1)*

It could be clearly asserted that the students liked voice feedback, these feedbacks caught their attention, they responded to these feedback and understood the feedback in line with the above-mentioned observations and interview findings.

B) Comparison of the Students' Responses According to Robot's Feedbacks Type

In this section was presented in the second research question scope for findings obtained by comparing the responses of the students to the feedbacks of the humanoid robots. Therefore, content analysis was realized by 1st researcher, 2nd researcher and special education expert. The video recordings during the application process were subjected to content analysis and the students' reactions to the feedbacks were calculated by giving points. The application video recordings were examined evaluations were made under categories of "noticing feedback" , " responding to feedback" and "willing participation and appreciation of the feedback". In order to determine the student response levels, the video recordings were evaluated and the responses under each theme (0 = none, 1 = few, 2 = medium, 3 = many) were scored. Averages of these scores were taken and the students' awareness of robot feedbacks were determined.

The first theme emerged in the analysis of student reactions is related to "being aware of feedback". The averages of the scorings were taken in the analysis made for the students to be aware of the robot feedbacks. The level of difference in each feedback was calculated and the results in Table 2 were obtained. This theme consisted of the following categories; the students were pointing to hand movements to robot's feedback, students touched the robot's physical feedback, students became sad when they gave wrong answers.

Table 2. Recognition of Feedbacks of Robot by Students

Feedback Types	**m**	**%**
Arm Feedbacks (Movement&Touch)	3	100
Bodily Feedbacks	3	100
Voice Feedbacks	2,66	88,6
Facial Expression Feedbacks	2	66,6
Screen Symbol Feedbacks	1	33,3
Head Feedbacks	0,66	22

When Table 2 was examined, it is seen that students mostly noticed arm movements and body feedbacks. It was observed that screen symbols and and head movement feedbacks of the robot was noticed by limited number of students.

Second analyzes were made for the theme "Students' reaction to robot feedbacks". The averages of the scores in the analyzes given the level of the students reactions were calculated. After the feedback of the robot, the students showed their reaction and excitement by being happy with their loud voices, taking their hands to their mouth and to the air. They have reacted by establishing eye contact with their teachers to share their success after marking their correct answers. The evaluations and point averages for the responses given by the students to the robot feedbacks are presented in Table 3.

Table 3. Student Responses to the Robot Feedbacks

Feedback Types	**m**	**%**
Arm Feedbacks (Movement&Touch)	3	100
Voice Feedbacks	2,66	88,6
Bodily Feedbacks	2,33	77,6
Facial Expression Feedbacks	1,33	44,3
Head Feedbacks	0,66	22
Screen Symbol Feedbacks	0,33	11

When Table 3 evaluated, all students responded with the highest mean value for the feedback generated by touching arm and arm movements. Students responded to second highest level feedback was generated by robot voice. It has been determined by researchers that students were at least in favor on head and screen feedbacks.

The average of the scores that occurred in the analyzes "willing participation and appreciation of the feedback" theme was calculated and evaluated. The student's applause of the robot's feedback, the smile that he was cheerful and willing, the student's attempt to shake hands with the robot's arm feedback, and the student's joke with the robot were the basis for this theme. As in above-mentioned categories, feedbacks in which the students in the study group willingly participated were feedbacks of arm movements, bodily feedbacks, and voice feedbacks. The evaluation for willing participation in the feedbacks is presented in Table 4.

Table 4. Willing Participation to the Robot's Feedbacks

Feedback Types	m	%
Arm Feedbacks (Movement&Touch)	3	100
Bodily Feedbacks	2,33	77,6
Voice Feedbacks	2,33	77,6
Facial Expression Feedbacks	1,33	44,33
Screen Symbol Feedbacks	0,33	11
Head Feedbacks	0,33	11

When Table 4 evaluated, the students made the most favorable participation and appreciation of feedback provided by touching arm and arm movements. As with other themes, the results for the screen and head feedbacks had a low level of willing participated and liked by students.

It was understood that assessment made in categories "noticing feedback", "responding to feedback", and "willingly participation to feedback" was similar with observation and interview findings. The teachers also stated that arm movements, bodily movements, and voice feedbacks drew the students' attention at most and they entered interaction more. Findings about the learning level of the working group are also limited only to the information obtained as a result of the interviews with their teachers. Teachers measured the students participating in robot assisted activities using the rough evaluation forms available in GRC. As a result of interviews with teachers, they stated that students learned more permanently and quickly when compared to traditional methods.

Discussion, Conclusion and Suggestions

In this study, interactions between students with mild mental disabilities and humanoid robot-assisted learning environment were examined in terms of feedback types. The study results were presented concerning students' responses against feedback types used in robot-assisted learning environment to be designed for students with mental retardation as well as design recommendations. In the study it was observed that the students with mild mental retardation met humanoid robot's feedbacks with appreciation and enthusiasm, gave comments, and joked. It was concluded that robot feedbacks drew their attention and increased their motivation. There were differences in responses given to robot feedbacks in terms of feedback types. Feedbacks which draw attention of the students with mild mental retardation with which they were interacted were arm feedbacks and bodily movements, the least given responded feedbacks were head movements and screen feedbacks.

The main results obtained in the research were presented below.

- "Touching the robot arm" feedback *(give me five)* when compared the among feedbacks created with the help of the robot's arm was the feedback in which all the students were interacted and which drew their attention. Another arm feedback is given by the up-and-down movement feedback of both arms, it could be asserted that even though it drew attention, it did not affect the students as much as "touching the robot arm" feedback. This could be associated with interaction caused by contact established physically with robot's arm. It was concluded that "touching the robot arm" feedback was remarkable feedback type and their usage including touching increased sincerity and communication. This result is in parallel with results of studies indicating that touching is important in perceiving and interpreting objects in students with mild mental retardation in the literature (Arpacık, 2014; Barreto & Benitti, 2012; Darıca, Abidoğlu, & Gümüşcü, 2002; Kulaksızoğlu, 2003; Özgüç & Cavkaytar, 2016).

- The feedbacks formed by the body movements was understood by students with mild mental retardation, were effective, and also attracted their attention. Feedbacks given by the bodily movement of the robot were "full round", "left and right dance movements", and "back-and-forward" movement. Since the students could not see the robot's facial expressions during the full round, after right-left short manoeuvre (dance movements) bodily movement feedback was found to be more appropriate. Han et al. (2008) stated that in addition to the gestures and facial expressions of robots, they had especially motion capabilities, and this capability ensured to transfer human's emotions more easily transfer.

- By using leds on the robot's face, feedbacks indicating human feelings such as sadness and happiness were noticed by the students but it was concluded that they were not as effective as bodily or arm feedbacks. In the literature it is stated that statements given with the face feedbacks of the robot are very important (Breazeal, 2003; Canamero, 1997; Sloman, 1981; Hsiao et al., 2012). However, in the present study a result partially opposed to this situation in the literature was obtained. This situation could be asserted to be associated with the use of the robot's bodily feedbacks with its face feedbacks. This situation can be explained by the interviews with the teachers and also the results of the observations. The first reason is that the head size of the robot's face was to small in the physical sense. As a second reason, it can be said that due to the combined use of face and body feedback, caused that the physical feedback may be dominant.

- Shamsuddin et al. (2012) stated that student with autism spectrum disorders interacted with the robot's head. However, in our study revealed that head feedback was the least perceived type of feedback by the students in humanoid robot iRobiQ. This case could be associated with small head of the robot and suppressing of the head feedback by other feedbacks. However, Breazeal (2003) stated that head feedbacks were very important in realistically perceiving the interactions in his study titled "Kismet-social robot design". This situation may have been caused by the fact Breazeal's study was conduced only with a robot head and human feelings was only transmitted by the face of the robot.

- Realistic human voice used in the robot was more effective and remarkable on students compared to audio feedback. In the second voice feedback formed with effects only "applaud" effect was observed to be effective. Additionally, Alessi and Trollip (2001) stated that the use of sound effects as feedback took students' attention . The results obtained in the present study revealed that when the sound effects were used together with humanoid robot feedbacks, it would be more effective.

- Students looked at the feedback at the robot's screen but any response or comment related to this feedback was not determined. The students were observed to be used the robot's screen for only answering questions and watching animations. This result can be explained as the students prefer human interaction involved with emotion and movement by robot. It is also possible that the presented digital image in iRobiQ robot's face figures were not considered human features by students. From this point on, the robot may only be perceived as an incomplete communication from the student who was in a human communication feedback expectation to given from on the screen. This communication can be similared to the fact that the answer of a student was true or false, written by the teacher. In this case, the student saw the message on the board, but waits for an additional response from the teacher. However, when the teacher presents many messages on the board (on the screen for the robot), the student would be interested.

- According to special education teachers and guidance counsellors' views, students left the lesson without permission, did not want to participate in, tore the activity papers before but they stated that in robot-assisted education, they participated to lessen with enthusiasm and as motivated. Besides, Patrizia, Claudio, Leonardo, and Alessandro (2009) stated that there were preliminary study results that robots could be used for therapy in the field of mentally disabled. Kakiuchi et al. (2009) expressed that the use of robots in the form of robot assistant or carer robots would be very useful for other types of obstacles. The results obtained in this study shows parallel results with the literature.

Since studies conducted in the field of special education by using humanoid robot technology is at initial stage and has a limited number, the present study is important in terms of bringing innovation to the literature. Humanoid robot is thought to make contribution in order to see its advantages related to attention and perception problems experienced by students as well as class control in special education due to its realistic and interacting features. It is also thought that this study is important for special education field and the use of instructional technologies in terms of enhancing quality of life of individuals with mental retardation, providing equality of opportunity and integrating with society.

The following suggestions would be beneficial for further researches or similar applications to the designers and practitioners to pay attention:

- Students in the study group were more likely to react and perceive more specifically robot arm, bodily movements and arm contact feedback. Therefore, when giving feedback to robots, especially physical contact and movement feedbacks should be used.

- While the physical movements are being prepared by the researchers, it should not have movements that will disturb the students.

- For a more efficient interaction in the learning environment, the attention should be paid to the height, head size and touch screen size of the robot to be used.

For future work in this regard, it was recommended that researchers used and compared robotics with different abilities and appearances. For example, the iRobiQ robot we used in our research had a limited possibility of humanoid appearance because it is able to move by its wheels. For this reason, a more human-like appearance could be achieved by using a robot that can moved through the legs in subsequent research. In addition, the study group can be expanded to different types of mental retardation and the effects of robot-assisted education on other disability groups can be observed. Another work to be done in the field of special education in this regard was the comparison of robots and other assistive technologies.

Acknowledgements

This study was supported by Erzincan University Administrative Coordination Office For Research Projects (Project Number: FEN-A-220114-0066). We would like to thank Assoc. Prof. Dr. Ahmet Ragıp ÖZPOLAT and Assist. Prof. Dr. Cihat ÖZGENEL for their support, valuable advices, and encouragement in the project.

References

Abbott, C., Brown, D., Evett, L., & Standen, P. (2014). Emerging issues and current trends in assistive technology use 2007–2010: practising, assisting and enabling learning for all. *Disability and Rehabilitation: Assistive Technology*, *9*(6), 453-462.

Akagi, T., Fujimoto, S., Kuno, H., Araki, K., Yamada, S., & Dohta, S. (2015). Systematic educational program for robotics and mechatronics engineering in OUS using robot competition. *Procedia Computer Science, 76,* 2-8.

Alessi, S. M., & Trollip, S. R. (2001). *Multimedia for learning: Methods and development* (3rd ed.). Massachusetts: A Pearson Education Company.

Arpacık, Ö. (2014). *Zihinsel engelli öğrencilere yönelikçoklu ortam materyallerinin geliştirme süreci ve kullanımının öğretmenlere ve öğrencilere etkisi* (Unpublished doctoral dissertation). Atatürk University, Institute of Educational Sciences, Erzurum.

Arslan, E. (2014). Yabancı dil öğretiminde robot öğretmenler. *Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi, 33*(1), 15-26.

Aziz, K. A., Aziz, N. A. A., Yusof, A. M., & Paul, A. (2012). Potential for providing augmented reality elements in special education via cloud computing. *Procedia Engineering, 41,* 333-339.

Barker, B. S., & Ansorge, J. (2007). Robotics as means to ıncrease achievement scores in an informal learning environment. *Journal of Research on Technology in Education, 39*(3), 229-243.

Barreto, F., & Benitti, V. (2012). Exploring the educational potential of robotics in schools: A systematic review. *Computers and Education, 58*(3), 978-988.

Bauml, B., Schmidt, F., Wimböck, T., Birbach, O., Dietrich, A., Fuchs, M., & Eiberger, O. (2011, May). Catching flying balls and preparing coffee: Humanoid rollin'justin performs dynamic and sensitive tasks. In *2011 IEEE International Conference on Robotics and Automation* (pp. 3443-3444). IEEE.

Berry, A. B., Petrin, R. A., Gravelle, M. L., & Farmer, T. W. (2011). Issues in special education teacher recruitment, retention, and Professional development: Considerations in supporting rural teachers. *Rural Special Education Quarterly, 30*(4), 3-11.

Bers, M. U., Flannery, L., Kazakoff, E. R., & Sullivan, A. (2014). Computational thinking and tinkering: Exploration of an early childhood robotics curriculum. *Computers & Education, 72*, 145-157.

Billard, A., Calinon, S., Dillmann, R., & Schaal, S. (2008). Robot programming by demonstration. In *Springer handbook of robotics* (pp. 1371-1394). Springer Berlin Heidelberg.

Bloss, R. (2011). High school student goes to class robotically. *Industrıal Robot-An Internatıonal Journal, 38*(5), 465-468.

Braddock, D., Rizzolo, M. C., Thompson, M., & Bell, R. (2004). Emerging technologies and cognitive disability. *Journal of Special Education Technology, 19*(4), 1-14.

Breazeal, C. (2003). Emotion and sociable humanoid robots. *Int. J. Human-Computer Studies, 59*(1-2), 119-155.

Brookhart, S. (2008). *How to give effective feedback to your students. Association for Supervision and Curriculum Development.* Alexandria, VA: Association for Supervision and Curriculum Development.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2010). *Bilimsel araştırma yöntemleri*. Ankara: Pegem Yayınları.

Campigotto, R., McEwen, R., & Demmans Epp, C. (2013). Especially social: Exploring the use of an iOS application in special needs classrooms. *Computers and Education, 60*(1), 74-86.

Canamero, D. (1997). Modeling motivations and emotions as a basis for intelligent behavior. In L. Johnson (Ed.), *Proceedings of the First International Conference on Autonomous Agents (Agents97)*, (pp. 148-155). ACMPress.

Carmien, S., & Wohldman, E. (2008). Mapping images to objects by young adults with cognitive disabilities. *Research in Developmental Disabilities, 29*(2), 149-157.

Cejka, E., Rogers, C., & Portsmore, M. (2006). Kindergarten Robotics: Using robotics to motivate math, science, and engineering literacy in elementary school. *Internaitonal Journal Engieering Education, 22*(4), 711-722.

Chambers, J. M., Carbonaro, M., & Murray, H. (2008). Developing conceptual understanding of mechanical advantage through the use of Lego robotic technology. *Australasian Journal of Educational Technology, 24*(4), 387-401.

Chang, C.-W., Lee, J.-H., Chao, P.-Y., Wang, C.-Y., & Chen, G.-D. (2010). Exploring the possibility of using humanoid robots as instructional tools for teaching a second language in primary school. *Educational Technology and Society, 13*(2), 13–24.

Chiang, H. Y. A., & Jacobs, K. (2010). Perceptions of a computer-based instruction system in special education: High school teachers and students views. *Work, 37*(4), 349-359.

Darıca, N., Abidoğlu, Ü., & Gümüşçü, Ş. (2002). *Otizm ve otistik çocuklar* (3. bs.). Ankara: Özgür Yayınları.

Dautenhahn, K., & Billard, A. (2002). Games children with autism can play with Robota, a humanoid robotic doll. In *Universal access and assistive technology* (pp. 179-190). Springer London.

DeMatthews, D., Edwards Jr. D. B., & Nelson, T. (2014). Identification problems: US special education eligibility for Englisih language learners. *International Journal for Educational Research, 68*, 27-34.

Dökmen, Ü. (1982). Geribildirimlerin öğrenmeye etkisi. *Ankara Üniversitesi Eğitim Bilimleri Dergisi,* 71-80.

Edwards, A., Edwards, C., Spence, P. R., Harris, C., & Gambino, A. (2016). Robots in the classroom: Differences in students' perceptions of credibility and learning between "teacher as robot" and "robot as teacher". *Computers in Human Behavior, 65*, 627-634.

Erişen, Y., & Çeliköz, N. (2009). *Eğitimde bilgisayar kullanımı. Öğretim teknolojileri ve materyal geliştirme.* Demirel, A. Ö., & Altun, E. (Eds.). Pegem Akademi, Ankara.

Everhart, J. M., Alber-Morgan, S. R., & Park, J. H. (2011). Effects of computer-based practice on the acquisition and maintenance of basic academic skills for children with moderate to intensive educational needs. *Education and Training in Autism and Developmental Disabilities, 46*(4), 556-564.

Fels, D. I., & Weiss, P. (2001). Video-mediated communication in the classroom to support sick children: A case study. *International Journal of Industrial Ergonomics, 28,* 251-263.

Fernandez-LóPez, Á., RodríGuez-FóRtiz, M. J., RodríGuez-Almendros, M. L., & MartíNez-Segura, M. J. (2013). Mobile learning technology based on iOS devices to support students with special education needs. *Computers & Education, 61*, 77-90.

Filgueiras, L. V. L., Prietch, S. S., & Preti, J. P. D. (2015). Empowerment of Assistive Technologies with Mobile Devices in a DUI Ecosystem. *Procedia Computer Science, 67*, 358-365.

Fridin, M. (2014a). Kindergarten social assistive robot: First meeting and ethical issues. *Computers in Human Behavior, 30,* 262-272.

Fridin, M. (2014b). Storytelling by a kindergarten social assistive robot: A tool for constructive learning in preschool education. *Computers and Education, 70,* 53-64.

Fuchs, M., Borst, C., Giordano, P. R., Baumann, A., Kraemer, E., Langwald, J., & Burger, R. (2009, May). Rollin'Justin-Design considerations and realization of a mobile platform for a humanoid upper body. In *2009 IEEE International Conference on Robotics and Automation Robotics and Automation* (pp. 4131-4137). IEEE.

Gagne, R. M. (1985). *The conditions of learning and theory of instruction* (4th ed.). New York, NY: Holt, Rinehart and Winston.

Garcia, V. S., Brown, L., Park, H. W., & Howard, A. M. (2014). Engaging children in play therapy: The coupling of virtual reality games with social robotics. In *Technologies of inclusive well-being* (pp. 139-163). Springer Berlin Heidelberg.

Gözün, Ö., & Yıkmış, A. (2004). Öğretmen adaylarının kaynaştırma konusunda bilgilendirilmelerinin kaynaştırmaya yönelik tutumlarının değişimindeki etkililiği. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Özel Eğitim Dergisi, 5*(2) 65-77.

Greczek, J., Short, E., Clabaugh, C. E., Swift-Spong, K., & Mataric, M. (2014, September). Socially Assistive Robotics for Personalized Education for Children. In *2014 AAAI Fall Symposium Series*.

Gudanescu, S. (2010). New educational technologies. *Procedia-Social and Behavioral Sciences*, *2*(2), 5646-5649.

Hackel, M., & Schwope, S. (2004). A humanoid interaction robot for information, negotiation and entertainment use. *International Journal of Humanoid Robotics*, *1*(03), 551-563.

Haksız, M. (2013). Investigation of tablet computer use in special education teachers' courses. *Procedia - Social and Behavioral Sciences, 141*(2014), 1392-1399

Han, J., Lee, S., Hyun, E., Kang, B., & Shin, K. (2009, Sept. 27 - Oct. 2). *The birth story of robot, IROBIQ for children's tolerance*. The 18th IEEE International Symposium on Robot and Human Interactive Communication Toyama, Japan.

Han, J., Jo, M., Jones, V., & Jo, J. H. (2008). Comparative Study on the Educational Use of Home Robots for Children. *Journal of Information Processing Systems*, *4*(4).

Hashimoto, T., Kato, N., & Kobayashi, H. (2011). Development of educational system with the android robot . *SAYA and Evaluation Int J Adv Robotic Sy*, *8*(3), 51-61.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81-112.

Heinich, R., Molenda, M., & Russell, J. D. (1993). *Instructional media and the new technologies of instruction*. New York: Macmillan.

Hixon, R. (2007). Teaching software engineering principles using robolab and lego mindstorms. *International Journal Engineering Education, 23*(5), 868-873.

Hsiao, H. S., Chang, C. S., Lin, C. Y., & Hsu, H. L. (2012). iRobiQ: the influence of bidirectional interaction on kindergarteners' reading motivation, literacy, and behavior. *Interactive Learning Environments*, *23*(3), 269-292. doi: 10.1080/10494820.2012.745435

Hung, I. J., Chao, K. J., Lee, L., & Chen, N. S. (2013). Designing a robot teaching assistant for enhancing and sustaining learning motivation. *Interactive Learning Environments, 21(2),* 156-171.

Huo, W., Mohammed, S., Moreno, J. C., & Amirat, Y. (2016). Lower limb wearable robots for assistance and rehabilitation: A state of the art. *IEEE Systems Journal*, *10*(3), 1068-1081.

Hyon, S.-H., Hale, J., & Cheng, G. (2007). Full-body compliant human-humanoid interaction: Balancing in the presence of unknown external forces. *IEEE Transactions on Robotics*, *23*(5), 884–898.

Hyun, E., & Yoon, H. (2009, September). *Characteristics of Young Children's Utilization of a Robot during Play Time : A Case Study,* The 18th IEEE International Symposium on Robot and Human Interactive Communication Toyama, Japan.

Hyun, E., Kim, S., Jang, S., & Park, S. (2008). *Comparative study of effects of language education program using intelligence robot and multimedia on linguistic ability of young children.* Proceedings of the 14th IEEE International Workshop on Robot and Human Interactive Communication (RO-MAN 2008). Piscataway, NJ: IEEE.

Hyun, E., Yoon, H., & Son, S. (2010, March). Relationships between user experiences and children's perceptions of the education robot. *HRI '10 Proceedings of the 5th ACM/IEEE international conference on Human-robot interaction* (pp. 199-200). Piscataway, NJ: IEEE Press.

Jackson, R. D. (1993). Robotics and its role in helping disabled peoples. *Engineering Science and Education Journal*, *2*(6), 267-272.

Jafari, N., Adams, K. D., & Tavakoli, M. (2016). Haptics to improve task performance in people with disabilities: A review of previous studies and a guide to future research with children with disabilities. *Journal of Rehabilitation and Assistive Technologies Engineering, 3*, 1-3.

Jonge, D., Scherer, M., J., & Rodger, S. (2007). *Assistive technology in the workplace.* Elsevier Health Sciences.

Jormanainen, I., Zhang, Y., Kinshuk, K., & Sutinen, E. (2007, March). Pedagogical Agents for Teacher Intervention in Educational Robotics Classes: Implementation Issues. In *Digital Game and Intelligent Toy Enhanced Learning, 2007. DIGITEL'07. The First IEEE International Workshop on* (pp. 49-56). IEEE.

Joyce, B., Weil, M., & Calhoun, E. (2000). *Models of teaching* (6th ed.). Needham Heights, MA: Allyn and Bacon.

Kakiuchi, Y., Nozawa, S., Yamazaki, K., Okada, K., & Inaba, M. (2013, November). *Assistive System Research for Creative Life Management on Robotics and Home Economics.* Paper presented at 2013 IEEE Workshop on Advanced Robotics and its Social Impacts (ARSO), Shibaura Institute of Technology, Tokyo, JAPAN.

Kanda, T., Hirano, T., Eaton, D., & Ishiguro, H. (2004). Interactive robots as social partners and peer tutors for children: A field trial. *Human-Computer Interaction, 19*(1), 61-84.

Karal, H. (2013). Özel eğitimde öğretim teknolojilerinin kullanımı. In K. Çağıltay & Y. Göktaş (Eds.), *Öğretim teknolojilerinin temelleri: Teoriler, araştırmalar, eğilimler* (1st ed., pp. 313-326) Ankara: Pegem Akademi.

Karal, H., Kokoç, M., & Ayyıldız, U. (2010). Educational computer games for developing psychomotor ability in children with mild mental impairment. *Procedia - Social and Behavioral Sciences, 9*, 996-1000.

Keren, G., & Fridin, M. (2014). Kindergarten Social Assistive Robot (KindSAR) for children's geometric thinking and metacognitive development in preschool education: A pilot study. *Computers in Human Behavior, 35,* 400-412.

Kim, C., Kim, D., Yuan, J., Hill, R. B., Doshi, P., & Thai, C. N. (2015). Robotics to promote elementary education pre-service teachers' STEM engagement, learning, and teaching. *Computers and Education*, *91*, 14-31.

Kose, H., Yorganci, R., Algan, E. H., & Syrdal, D. S. (2012). Evaluation of the robot assisted sign language tutoring using video-based studies. *International Journal of Social Robotics*, *4*(3), 273-283.

Kozima, H., Nakagawa, C., & Yasuda, Y. (2007). Children-robot interaction: A pilot study in autism therapy, *Progress in Brain Research*, *164*, 385-400.

Kulaksızoğlu, A. (2003). *Farklı gelişen çocuklar* (1st ed.). İstanbul.

Kuzu, A. (2007). *Bilgisayar destekli öğretimde kullanılan yaygın formatlar. Bilgisayar I-II, Temel Bilgisayar Becerileri.* A. Güneş (Ed.). Ankara: Pegem A Yayıncılık.

Lieto, M. C., Inguaggiato, E., Castro, E., Cecchi, F., Cioni, G., Dell'Omo, M., & Dario, P. (2017). Educational Robotics intervention on Executive Functions in preschool children: A pilot study. *Computers in Human Behavior*, *71*, 16-23.

Lin, C. Y., Chai, H. C., Wang, J. Y., Chen, C. J., Liu, Y. H., Chen, C. W., & Huang, Y. M. (2016). Augmented reality in educational activities for children with disabilities. *Displays, 42*(0), 51-54.

Lin, E. K., Bednarik, K. P., Erkki Sutinen, E., & Virnes, M. (2006). *Can Robots Teach? Preliminary Results on Educational Robotics in Special Education*. IEEE Computer Society Proceedings of the Sixth International Conference on Advanced Learning Technologies (ICALT'06*).*

Lin, L., Atkinson, R. K., Christopherson, R., Joseph, S., & Harrison, C. (2013). Animated agents and learning: Does the type of verbal feedback they provide matter? *Computers and Education, 67*, 239-249.

Liu, G. Z., Wu, N. W., & Chen, Y., W. (2013). Identifying emerging trends for implementing learning technology in special education: A state-of-the-art review of selected articles published in 2008–2012. *Research in Developmental Disabilities, 34*, 3618-3628.

Mason, B. J., & Bruning, R. (1999). Providing feedback in computer-based instruction: What the research tells us. Retrieved December 10, 2014, from http://dwb.unl.edu/Edit/MB/MasonBruning.html

Mayer, R. E. (2002). Multimedia learning. *Psychology of Learning and Motivation*, *41*, 85-139.

McMillan, J. H., & Schumacher, S. (2010). *Resarch in education: Evidence based inquiry* (7th ed.). Boston - USA: Kevin M. Davis.

Mirandola, C., Losito, N., Ghetti, S., & Cornoldi, C. (2014). Emotional false memories in children with learning disabilities. *Research in Developmental Disabilities*, *35*(2), 261-268.

Nagata, N. (1993). Intelligent computer feedback for second language instruction. *Modern Language Journal*, *77*(3), 330-339.

Narciss, S., Sosnovsky, S., Schnaubert, L., Andrès, E., Eichelmann, A., Goguadze, G., & Melis, E. (2014). Exploring feedback and student characteristics relevant for personalizing feedback strategies. *Computers & Education*, *71*, 56-76.

Oguntosin, V., Harwin, W. S., Kawamura, S., Nasuto, S. J., & Hayashi, Y. (2015, August). Development of a wearable assistive soft robotic device for elbow rehabilitation. In *2015 IEEE International Conference on Rehabilitation Robotics (ICORR)* (pp. 747-752).

Oztop, E., Franklin, D. W., Chaminade, T., & Cheng, G. (2005). Human–humanoid interaction: Is a humanoid robot perceived as a human?. *International Journal of Humanoid Robotics*, *2*(04), 537-559.

Özerbaş, S. D. (2007). Sınıfta olumlu öğrenme ortamı oluşturma. In M. Ç. Özdemir (Ed.), *Sınıf yönetimi* (pp. 51-75). Ankara: Ekinoks Yayınları.

Özerbaş, S. D. (2007). Sınıfta olumlu öğrenme ortamı oluşturma. In M. Ç. Özdemir (Ed.), *Sınıf yönetimi* (pp. 51-75). Ankara: Ekinoks Yayınları.

Özgüç, C. S., & Cavkaytar, A. (2016). Zihin yetersizliği olan ortaokul öğrencilerinin bulunduğu bir sınıfta öğretim etkinliklerinin teknoloji desteği ile geliştirilmesi. *Eğitim ve Bilim*, *41*(188), 197-226. doi:10.15390/EB.2016.6691

Öztürk, M., Akkan, Y., Büyüksevindik, B., & Kaplan, A. (2016). Hafif düzeyde zihinsel yetersizliği olan öğrencilerin sanal manipulatifler yardımıyla toplama işlemi öğrenimi: Bir çoklu durum çalışması. *Eğitim ve Bilim*, *41*(188), 175-196. doi:10.15390/EB.2016.6582

Panek, P. E., & Jungers, M. K. (2008). Effects of age, gender, and causality on perceptions of persons with mental retardation. *Research in Developmental Disabilities*, *29*(2), 125-132.

Park, H. W., Coogle, R. A., & Howard, A. (2014, May). Using a shared tablet workspace for interactive demonstrations during human-robot learning scenarios. In *2014 IEEE International Conference on Robotics and Automation (ICRA)* (pp. 2713-2719). IEEE.

Park, S., Han, J., Kang, B., & Shin, K. (2011). *Teaching assistant robot, ROBOSEM, in English class and practical issues for its diffusion.* Proceedings of IEEE A Workshop on Advanced Robotics and its Social Impacts. Retrieved from http://www.arso2011.org/papers

Park, Y. L., Santos, J., Galloway, K. G., Goldfield, E. C., & Wood, R. J. (2014, May). A soft wearable robotic device for active knee motions using flat pneumatic artificial muscles. In *2014 IEEE International Conference on Robotics and Automation (ICRA)* (pp. 4805-4810).

Patrizia, M., Claudio, M., Leonardo, G., & Alessandro, P. (June, 2009). *A Robotic Toy for Children with special needs: From requirements to design.* 2009 IEEE 11th International Conference on Rehabilitation Robotics Kyoto International Conference Center, Japan.

Pennington, R. C. (2010). Computer-assisted instruction for teaching academic skills to students with autism spectrum disorders: A review of literature. *Focus on Autism and Other Developmental Disabilities*, *25*(4), 239-248.

Petre, M., & Price, B. (2004). Using robotics to motivate 'Back Door' learning. *Education and Information Technologies, 9*(2), 147-158.

Pieska, S., Luimula, M., Jauhiainen, J., & Spiz, V. (2013). Social service robots in wellness and restaurant applications. *Journal of Communication and Computer*, *10*(1), 116-123.

Piranda, B., Laurent, G. J., Bourgeois, J., Clévy, C., Möbes, S., & Le Fort-Piat, N. (2013). A new concept of planar self-reconfigurable modular robot for conveying microparts. *Mechatronics*, *23*(7), 906-915.

Povian, C. P., Gurza, V. G., & Dumitrescu, C. (2013). Special education tools, concepts and design for children in need. *Procedia - Social and Behavioral Sciences, 141*, 996-1002.

Rabbitt, S. M., Kazdin, A. E., & Scassellati, B. (2015). Integrating socially assistive robotics into mental healthcare interventions: Applications and recommendations for expanded use. *Clinical Psychology Review*, *35*, 35-46.

Rahman, M. H., Rahman, M. J., Cristobal, O. L., Saad, M., Kenné, J. P., & Archambault, P. S. (2015). Development of a whole arm wearable robotic exoskeleton for rehabilitation and to assist upper limb movements. *Robotica*, *33*(1), 19.

Rezaiyan, A., Mohammadi, E., & Fallah, P. A. (2007). Effect of computer game intervention on the attention capacity of mentally retarded children. *International Journal of Nursing Practice, 13*(5), 284-288.

Rodriguez, C., Guzman, J. L., Berenguel, M., & Dormido, S. (2016). Teaching real-time programming using mobile robots. *IFAC-PapersOnLine*, *49*(6), 10-15.

Russell, J. (1997). Reading emotions from and into faces: Resurrecting a dimensional–contextual perspective. In Russell, J., & Fernandez-Dols, J. (Eds.), *The Psychology of Facial Expression (*pp. 295–320). UK: Cambridge University Press, Cambridge.

Scheeler, M. C., & Lee, D. L. (2002). Using technology to deliver immediate corrective feedback to preservice teachers. *Journal of Behavioral Education, 11*(4), 231-241.

Seifer, F. D., & Mataric, M. J. (2005, June 28 - July 1). *Defining Socially Assistive Robotics.* Proceedings of the 2005 IEEE 9th International Conference on Rehabilitation Robotics, Chicago, IL, USA

Senemoğlu, N. (2010). *Gelişim öğrenme ve öğretim: Kuramdan uygulamaya*. Ankara: Pegem.

Shamsuddin, S., Yussof, H., Ismail, L. I., Mohamed, S., Hanapiah, F., A., & Zaharid, N. I. (2012). Initial response in HRI- a case study on evaluation of child with autism spectrum disorders interacting with a humanoid robot NAO. *Procedia Engineering, 41,* 1448-1455.

Simons, J., & Dedroog, I. (2009). Body awareness in children with mental retardation. *Research in Developmental Disabilities*, *30*(6), 1343-1353.

Sloman, A. (1981). *Why robots will have emotions.* Paper presnted at IJ-CAI81, Vancouver, Canada.

Tapus, A., Peca, A., Aly, A., Pop, C., Jisa L., Pintea, S., … David, D. (2012). Children with autism social engagement in interaction with Nao, an imitative robot: A series of single case experiments. *Interaction Studies*, *13*, 315-347.

Tekin, E., & Kırcaali, I. G. (1997). *Tek denekli araştırma yöntemleri* (1st ed.). Ankara: Türk Psikologlar Derneği Yayınları.

Türkiye Zihinsel Engelliler Vakfı. (2014). Zihinsel Engellilik Nedir?. Retrieved December 24, 2015, from http://www.zihinselengellilervakfi.org/zengeltanimi.html

Urbano, R. C., & Hodapp, R. M. (2011). Developmental epidemiology of mental retardation and developmental disabilities: An emerging discipline*. Developmental Epidemiology of Mental Retardation And Developmental Disabilities*, 3-24. doi:10.1016/s0074-7750(06)33001-7

Valadao, C. T., Loterio, F., Cardoso, V., Bastos, T., Frizera-Neto, A., & Carelli, R. (2015). Robotics as a tool for physiotherapy and rehabilitation sessions. *IFAC-PapersOnLine*, *48*(19), 148-153.

Wang, S. L., & Wu, P. Y. (2008). The role of feedback and self-efficacy on web-based learning: The social cognitive perspective. *Computers & Education, 51*(4), 1589-1598.

Wei, C. W., Hung, I. C., Lee, L., & Chen, N. S. (2011). A joyful classroom learning system with robot learning companion for children to learn mathematics multiplication. *Turkish Online Journal of Educational Technology, 10*(2) 11-23.

White, D. H., & Robertson, L. (2015). Implementing assistive technologies: A study on co-learning in the Canadian elementary school context. *Computers in Human Behavior*, *51*, 1268-1275.

Wu, T.-F., Chen, M.-C., Yeh, Y.-M., Wang, H.-P., & Chang, S. C.-H. (2014). Is digital divide an issue for students with learning disabilities?. *Computers in Human Behavior, 39*, 112-117. doi:10.1016/j.chb.2014.06.024

Yanpar, T. (2006). *Öğretim teknolojileri ve materyal tasarımı* (7th ed.). Ankara: Anı Yayıncılık.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). SAGE Puplications.

Yujin Robot. (2015). *iRobiQ robot.* Retrieved from http://en.yujinrobot.com

ZEDEP (2008). Zihinsel engelli bireyler destek eğitim programı. Retrieved from http://orgm.meb.gov.tr/meb_iys_dosyalar/2013_09/04010347_zihinselengelli bireylerdestekeitimprogram.pdf