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Effectiveness of Explicit Teaching Using Augmented Reality in Teaching Sensory Organs to Students with Autism Spectrum Disorder

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SUMMARY

In this study, it was aimed to determine the effectiveness of the explicit teaching method using ¨Augmented Reality (AR)¨ in teaching sensory organs to students with¨Autism Spectrum Disorder (ASD)¨. The participants of this research are consist of three male students with ASD. They are attending Special Education Vocational School. The design of this research is the multiple probe design with probe conditions across subjects. The dependent variable of the research is the learning level of the structure and functions of the sensory organs of the students with ASD. The independent variable is the explicit teaching method using AR. The findings indicated that the explicit teaching method using AR is effective in teaching the structure and functions of the sensory organs in three students with ASD. It was revealed that the participants maintained their acquisitions about sensory organs they learned in the 1st, 2nd and 3rd weeks. Additionally, generalization data indicated that three students with ASD generalized the skills they learned.

Keywords: Autism spectrum disorder, sensory organ, explicit teaching method, augmented reality

INTRODUCTION

Autism Spectrum Disorder (ASD) is defined as a neuro-developmental disorder characterized by the inadequacies and difficulties in communication and social interaction, as well as the presence of limited interest and repetitive behaviors (Diagnostic and Statistical Manual of Mental Disorders [DSM-5], 2013, as cited in Berenguer et al., 2020). When students with ASD are not provided with the necessary special educational services through appropriate educational arrangements, the lives of both students with ASD and those responsible for them are adversely affected (Güleç-Aslan, Kırcaali-İftar & Uzuner, 2009). While children with normal development can learn independent living or academic skills by modeling the people around them or by making use of existing educational opportunities, children with ASD can learn through systematic teaching practices such as constant delay, *simultaneous prompting procedures*, activity schedules, video-enhanced activity schedules, and explicit instruction (Kurt, 2006). For example; especially explicit instruction is widely used among the evidence-based practices that is conducted in the form from easy to difficult for students with ASD and other developmental disabilities (Yıkmış & Özçakır, 2019, as cited in Yavuz, Karaaslan & Yıkmış, 2021).

Due to the increasing prevalence of individuals with ASD, the need for effective, evidence-based interventions for ASD is growing exponentially (Gitimoghaddam et al., 2022). While normally developing children can learn many skills by taking advantage of existing educational opportunities or by taking models from those around them; it is claimed that students with special needs (e.g., children with ASD) need to make different arrangements in their education in order to learn many skills and that they need to receive systematic education with evidence-based practices (Kurt, 2006). "No Child Left Behind (2002)" and "Individuals with Disabilities Education Improvement Act (2004)", which are regulated for individuals with disabilities in the United States, it requires teachers to compulsory use evidence-based teaching practices when teaching students with ASD and other developmental disabilities (Spooner et al., 2012). In the report published by the ¨The National Autism Center (NAC)¨ in 2019, technology-based practices are among the promising practices. On the other hand, ¨Technology-Aided Instruction and Intervention" is asserted that evidence-based practice in the 2014 report of the "National Professional Development Center (NPDC)" on ASD. Therefore, it is seen that technology-based intervention methods are frequently used in the interventions for students with ASD and are among evidence-based practices (Wong et al., 2014, as cited in Odluyurt & Çattık, 2018). It is seen that the use of technology has started to be widely used to support the learning of children with ASD. For this purpose, target behaviors for students with ASD are tried to be taught with compatible applications (for example: Apple Store and Google Play Store) with tablets and smart phones (Rakap, Birkan & Kalkan, 2017).

Although *"Augmented Reality (AR)"* interventions are very new in the literature, AR reveals very important results for individuals with disabilities regarding social interaction and communication skills (Sani-Bozkurt, 2017). Similarly, AR interventions are seen to be used in the field of special education and AR technologies are also thought to offer a new and different experience for teaching individuals with ASD (Bahçalı & Odluyurt, 2021). For example; in the study conducted by Cihak et al. (2016) examines the effects of AR to teaching brushing teeth to three students with ASD. The results revealed that all students learned how to brush their teeth independently. In another study by Bai, Blackwell & Coulouris (2014), it was examined whether augmented reality is effective on teaching pretend play to young children with ASD. The findings of the study showed that "Augmented Reality" was effective in teaching pretend play to children with ASD. In the study conducted by Коломоєць (2018), it was determined that AR is effective in teaching reading to children with ASD.

By using AR and VR, students have the opportunity to explore and interact with objects in a way that is not possible in the physical world. Although AR and VR might sound similar, it is known that they are two different technologies with different purposes. VR technology immerses users in a totally new digital environment by providing an interactive experience via the use of headsets or glasses. On the other hand, AR technology supplements the real-world environment by placing digital objects on it, enriching it with extra information. Therefore, VR enable virtual interactions by providing sensory experiences in artificial environments through the computers (Al-Ansi et al., 2023). Nowadays, VR is claimed to be actively used in the educational context in almost all disciplinary fields (İskender & Erkan, 2023). But, specifically, interaction with VR often requires the use of a special VR headset, which can be difficult to use for many children with ASD. Morever, AR technologies are simpler and more versatile as they use a wide variety of devices such as tablets or "Smartphones" that better adapt the interaction to the real world (Berenguer et al., 2020). Therefore, the devices on which VR interventions; it should be handled differently from simulations and classical three-dimensional virtual environments, as it provides the feeling of immersion and presence at a distance by appealing to multiple senses such as vision, hearing, touch and smell, and provides high-level interaction opportunities that are close to real life activities (Bütün et al., 2019). Hereby, AR is actually an intervention that allows you to interact with virtual objects in the real world (Bronack, 2011, as cited in Sani-Bozkurt, 2017).

Research findings on AR indicated that in the teaching sessions to be held for children with ASD, it allows them to interact with the three-dimensional multidimensional model that provides sound and image together in learning different skills (Tentori, Escobedo & Balderas, 2015, as cited in Khowaja et al., 2020). In the study conducted by Khowaja et al. (2020), studies conducted from 2005 to 2018 on the use and effectiveness of AR in developing various skills of children and adolescents diagnosed with ASD were reviewed. The results obtained from these evidence-based studies has been shown that AR is interesting in children with ASD and also AR benefited children with ASD in learning skills (Khowaja et al., 2020). For example; Khowaja et al. (2020) reviewed studies on the use of AR in the improve various skills by children and adolescents with ASD between 2005 and 2018 in eight databases. The results show that augmented reality benefits children with ASD in the acquisition of learning skills.

There are researches on the effectiveness of graphic organizers presented with the constant time delay teaching method on teaching science concepts with ASD (Sazak Pınar & Merdan, 2016) and also the teaching of science experiments (mixture-separation experiments) to students with ASD with a video-enhanced activity schedule (Elmaci & Karaaslan, 2021). Considering the researches carried out using AR; Teaching symbolic play skills to children with ASD (Bai, Blackwell & Coulouris, 2014), increasing and maintaining focus on objects (Escobedo et al., 2014), and teaching social stories (Syahputra et al., 2017). When we look at the studies carried out using augmented reality in Turkey, there is research on the effectiveness of the concept map presented with AR in teaching the basic characteristics of animals to students with intellectual disabilities (Yavuz, Karaaslan & Yıkmış, 2021). In addition, it is seen that there are researches (for example; Terzioğlu, 2020; Karaaslan, 2023) on the effectiveness of web-based virtual manipulatives on the teaching of basic calculation skills (addition, subtraction, multiplication and division) to students with intellectual disabilities has been carried out. In this study, the effectiveness of the explicit instruction method presented with AR in teaching sensory organs to students with ASD was examined. The purpose of this research is to determine the effectiveness of the explicit instruction method presented with AR on teaching sensory organs to students with ASD. In line with this purpose, answers to the following questions will be sought. These;

1. Is the ¨Explicit Instruction Method (EIM)¨ presented with AR effective on teaching the structure and functions of sensory organs to students with ASD?
2. After the EIM presented with AR, do students with ASD maintain their performance on their sense organs after intervention sessions were finished (1, 2 and 3 weeks)?
3. After the EIM presented with AR is implemented, can students with ASD generalize the performance they will display regarding their sense organs acrross different environments and people?

METHOD

Research Design

Multiple probe design with probe conditions across subjects was used to determine whether EIM presented with ¨Augmented Reality (AR)¨ is effective in teaching sensory organs to students with ASD. Single-subject research designs, which allow the effect of the independent variable to be observed experimentally on the independent variable, are widely used in research conducted for students with special needs (Horner et al., 2005). In this research design, the baseline data is collected simultaneously until at least three stable data are obtained for each participant in the research. When stable data is obtained in all subjects at the baseline level, the intervention phase is started with the first subject. During the intervention phase, daily probe data were collected after each intervention session. In the application phase with the first subject, when stable data is reached for at least three consecutive sessions, a full probe session is started for all subjects. A similar process was carried out in the same way with other subjects (second and third subjects). A similar process was carried out with the other subjects (with the second and third subjects) in the same way. After full probes, maintenance and generalization sessions were held (Tekin-İftar, 2012).

Participants

The participants of the research were carried out with three *¨Autism Spectrum Disorder (ASD)¨* students aged between 16 and 18 who lived in Istanbul. These students attend a special education vocational school. Participants of this research were determined by considering prerequisites. These prerequisites are; (1) being diagnosed with ASD, (2) not being able to tell the characteristics of sensory organs, (3) having receptive and expressive language skills as required by the research, (4) being able to watch an AR intervention, as well as to engage on a specific activity for at least 10 minutes, (5) at a level that prevents working not have behavioral problems (eg hitting, spitting, standing up), (6) being able to follow and fulfill verbal instructions.

The families of the students with ASD who had the prerequisites mentioned above were informed, and three participants were determined by obtaining the written consent of the parents who volunteered to participate in the research. All of the participants are male. The names of the participating students were not used in the study, each of them was given a code name. The first participant named Deniz is 16 years old. has been diagnosed with OSB and he is a special education vocational school student. He has basic academic (mathematics and literacy) skills. He is able to follow written and verbal instructions she. He can focus his attention on an activity for at least 10 minutes. He knows the names of the sense organs but cannot express their properties. The second participant named Bulut is 18 years old. He has a diagnosis of ASD and has basic academic skills. He is able to describe the events she has experienced in simple sentences, and he is able to write the sentences told to his. He is able to focus his attention on the activity for at least 10 minutes. He knows the names of some sense organs but cannot express their properties. The third participant named Rüzgâr is 17 years old. There is a diagnosis of ASD. He is a student at a special education vocational school and receives supportive education. He has basic academic skills. He is able to focus his attention on the activity for at least 10 minutes. He knows the names of some sense organs but cannot express their properties.

Dependent and Independent Variable of the Research

The dependent variable of this research is the level of learning the structure and functions of sensory organs of the students with ASD. The independent variable is the EIM presented with AR.

Setting and Data Collection Tools

The intervention was conducted in a room of 24 m^2. There is a table and two chairs in the room. Before the intervention sessions, materials and materials that were not related to instruction and that could distract attention were removed from the setting. Teaching materials and tools are properly placed. Baseline data, intervention sessions, daily probe sessions and full probe were carried out throughout the study period.

In the intervention sessions, *"Our Body 4D Augmented Reality Cards (Vücudumuz 4D Arttırılmış Gerçeklik Kartları)"* and the application downloaded from Google Play were used. A 10-inch Lenova tablet computer was used to present the augmented reality content throughout the study. The function, internal structure and properties of each sensory organ were presented to the students visually and audibly in an augmented reality. For example; while presenting the content related to the ear, the functions of the ear (hearing and balance), the structure of the ear (inner ear, middle ear and outer ear) and how hearing occurs are conveyed using augmented reality. Picture cards related to the characteristics of the sensory organs were used In the baseline, probe, maintenance and generalization sessions. These cards, which are printed in color in A4 size, show the detailed structure of the sense organs. All sessions were recorded with a SONY brand camera. During the research, participant performance data were kept with a data recording form.

General Process

Research process; it consists of obtaining necessary permissions, collecting baseline data, daily probe and full probe sessions, maintenance (follow-up) and generalization data. In addition, ethics committee approval was obtained from Trakya University Social and Human Sciences Research Ethics Committee with the approval number of 324612 (session number: 2022/08) dated 26.09.2022.

Baseline Probe Sessions

Baseline probe sessions were taken in the room. Color pictures of the sensory organs and data recording form were used in the baseline probe sessions, which were held simultaneously with all three participants. At baseline probe sessions, the practitioner and the student are seated at the table. The practitioner asks the student “are you ready to work together?” and then starts the session. He reinforced the student's cooperative behavior by "banging". Practitioner “now I'm going to ask you some questions and I want you to answer the questions I asked you.” says. A picture of the relevant sensory organ is placed in front of the student, “Say the name of this organ.”, “Tell the function of this organ”, “Tell me the internal structure of this organ?”, “Show the inner ear.”, “Show the middle ear.”, “Show the outer ear.” He asked questions that would reflect the student's performance, including all sense organs. The student's correct and incorrect responses were recorded in the data recording form. In this process, only the student's cooperative behavior was reinforced.

Intervention Sessions

After baseline probe sessions were completed, the intervention sessions were started. Intervention sessions are arranged as one session per day on weekdays. In the intervention sessions, instruction content for the sense organs was presented with the augmented reality technology offered through the tablet computer. In this content, there are visuals and audio explanations of the sense organs. Students and practitioners can reduce and enlarge the image on the screen of the tablet computer and rotate it 360 degrees. Therefore, augmented reality content includes opportunities for interaction. The contents exhibit both the external appearance of the organs and the parts that are not visible from the outside.

Social reinforcers and activity reinforcers were used as reinforcers in the intervention phase. Student's correct responses were reinforced with social reinforcements such as "well done, bravo, very correct". The student's wrong responses or unresponsive situations were ignored. Appropriately completed intervention sessions were reinforced with an activity in the form of listening to a song chosen by the student together. Food reinforcers were not preferred because the students were adolescents and had academic study habits. The intervention in this study were carried out by the second author. In the intervention, the student and the practitioner sat side by side at the table. The practitioner asked the student, “are you ready to work?” and thus has been drawed the student's attention to the study. After the student's response stating that he is ready, the practitioner explains the purpose of the session. “Today we will learn the characteristics of the …… from our sense organs. After learning about this subject, we will be able to answer all questions about the internal structure, function and functioning of the ……, which is a very important sense organ.” presents the augmented reality content to the student after an explanation such as: Then the practitioner moves to the modeling phase. At this stage, the features, internal structure and functioning of the taught sense organ are explained to the student by using the image of AR. After sufficient repetitions are made in the modeling phase, the guided intervention phase is started. At this stage, the student is guided by giving verbal clues at the points he needs. After sufficient repetition in the guided intervention phase, the student is expected to independently explain the features, internal structure and functioning of the studied organ on an AR image. After the independent intervention phase, the sessions of the relevant body were completed.

Probe Sessions

Dailly Probe Sessions. Daily probe was carried out similarly to the baseline sessions. Daily probe sessions were held after each intervention session.

Full Probe Sessions. When each subjects met the criterion related to target behavior (telling the characteristics of the sensory organs) and stable data were obtained in the intervention phase, then full probe session was carried out. Therefore, full probe sessions were held with each participant after the intervention phase was completed. Full probe sessions were also conducted in a similarly to baseline probe sessions.

Maintenance and Generalization Sessions

Maintenance sessions (follow-up session) were held to see if the behaviors that the participants learned with explicit instruction method presented with AR in the teaching of sensory organs were preserved after the intervention was completed (one, two, and three weeks later). The generalization sessions was conducted with another implementer to see whether the information learned are generalized. Generalization sessions were conducted by using the pre-test and post-test model. No help or clues were given to any participant during the maintenance (follow-up) and generalization sessions.

Data Collection and Analysis

In the study, which aims to determine the effectiveness of the explicit instruction method presented with AR in the teaching of sensory organs to students with ASD, probe, maintenance, generalization, effectiveness and reliability data were collected. While data were collected from the participants, the correct responses of the participants were recorded with the (+) symbol and the wrong responses were recorded with the (-) symbol. Each data group was calculated as a percentage and recorded in accordance with the graphic.

The Effectiveness Data ve Analysis

Baseline, probe, intervention, maintenance and generalization data obtained during the research was recorded by using the data analysis form. Then, the obtained data were analyzed by visual analysis.

Reliability Data and Analysis

Inter-Observer Reliability: In the research, all sessions for the "Inter-Observer Reliability" data were recorded with a video camera. Then, for each participant, 30% of the total sessions were determined randomly. The recordings of the determined sessions were monitored by a teacher with a master's degree, and they were asked to keep inter-observer reliability data. In the study, the *"Agreement/(Agreement + Disagreement x 100"* formula (Ayres & Gast, 2010) was used for inter-observer reliability data. Inter-observer reliability data of the participants are presented in Table 2.1.

Table 2. 1. Inter-Observer Reliability Data of the Participants

Sessions	Inter-Observer Reliability Data
Daily Probes Sessions	%95 (range %92-100)
Full Probes Sessions	%90 (range %80-100)
Maintenance Sessions	%92 (range %88-100)
Generalization Sessions	%95 (range %90-100)

Treatment Reliability. The formula of *"observed practitioner behavior/planned practitioner behavior x 100"* (Ayres & Gast, 2010) was used to analyze the data. As a result of the calculation, it was seen that the researcher carried out all sessions at 100% reliability level.

FINDINGS

In this study, the graphs of the data on the effectiveness of the explicit instruction method using AR in teaching the structure and functions of sensory organs to students with ASD were given in figure 3. 1. In the figüre 3.1, there are the percentage of correct answers of the structure and functions of sensory organs in the baseline, intervention and maintenance data for all students with ASD who participated in the research.

Findings About the Participants

*Acquisition Findings about Deniz***.** When the baseline data in Figure 3. 1 about Deniz's on *"structure and function of the sense organs""* are analyzed, it is seen that Deniz gave an average of 12.5% correct response in the baseline sessions. In other words, it can be said that the student has very limited correct responses in the structure and functions of the sensory organs. After obtaining the baseline data with Deniz, 9 intervention sessions were conducted with explicit instruction method presented with AR. At the end of each intervention session, daily probe data was collected and graphed by calculating as a percentage. According to these daily probe data, it is seen that Deniz exhibited an average of 72% (range 12.5%-100%) correct response and met the criterion by maintaining a 100% correct behavior percentage in the last three sessions.

*Acquisition Findings about Bulut***.** It has been determined that Bulut's baseline data on the structure and function of the sense organs is at an average of 12.5%. In other words, Bulut had limited correct responses in terms of the structure and function of the sensory organs. A total of 13 intervention sessions were held with this participant. According to the daily probe data taken after these intervention sessions, Bulut responded correctly on average 74% (range 25%-100%) and met the criterion by responding 100% correctly in the last three sessions.

*Acquisition Findings about Rüzgar***.** When the baseline data in Figure 3. 1 about Deniz's on *"structure and function of the sense organs""* are analyzed, it is seen that Deniz gave an average of 0% correct response in the baseline sessions. In other words, Rüzgar did not respond correctly with the structure and functioning of her sense organs before the intervention sessions. According to the daily probe data taken after 10 intervention sessions with explicit instruction method presented with AR, Rüzgar gave an average of 64% (range 25%-100%) correct response and met the criterion by showing 100% correct response in the last three sessions.

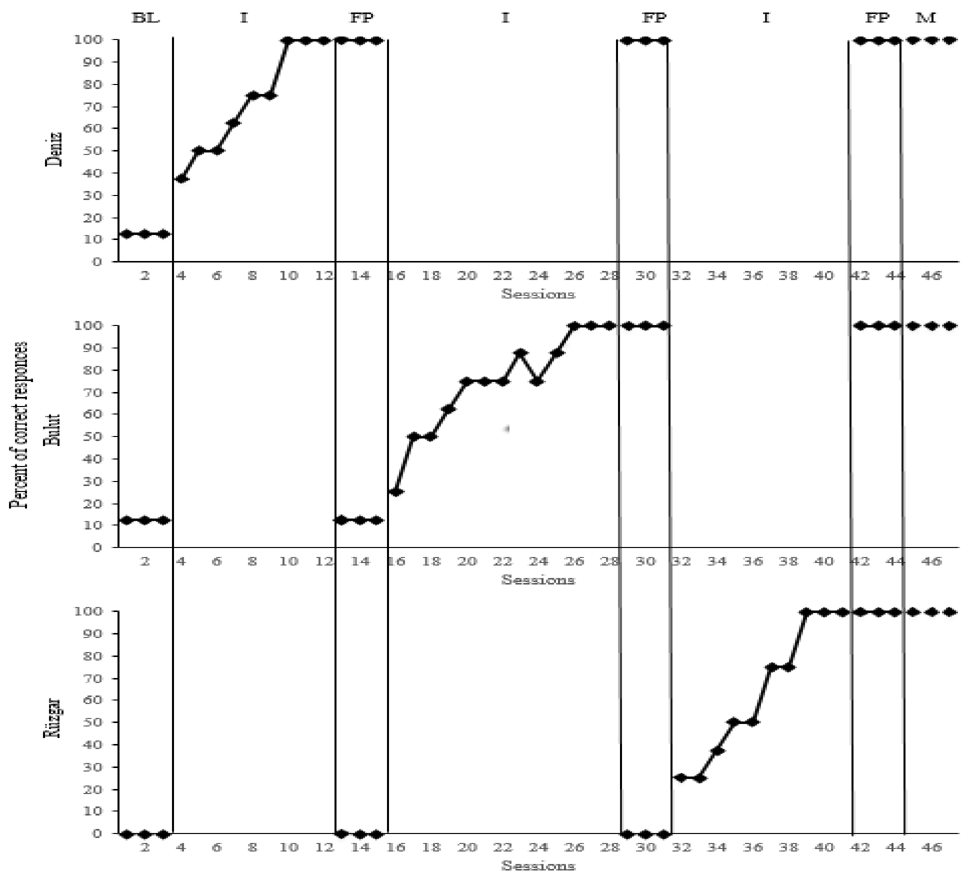

Figure 3. 1. Percentages of Deniz's, Bulut's and Rüzgar's correct answers regarding the sensory organs in Baseline (BL), Intervention (I), Full Probe (FP), and Maintenance (M) sessions.

Findings of Participants Regarding Maintanence and Generalization

After intervention sessions by using explicit instruction method presented with AR in teaching the sense organs were completed with all participants, follow-up sessions were held 1, 2 and 3 weeks later in order to understand whether the gains were preserved or not. According to the data of the maintenance sessions, Deniz, Bulut and Rüzgar maintained their gains by meeting the 100% criterion in the sessions 1, 2, and 3 weeks later. Therefore, it has been understood that the explicit instruction method presented with AR in the teaching of the structure and function of the sensory organs provides permanence. Additionally, it was observed that Deniz, Bulut and Rüzgar gave 100% correct response in the generalization sessions on the structure and function of the sensory organs. Generalization data indicated that Deniz, Bulut and Rügar generalized the skills they learned.

DISCUSSION

In this study, it was revealed that students with ASD learned about their sense organs through the explicit instruction method presented with ¨Augmented Reality (AR)¨. In addition, it was determined that students with ASD made what they learned maintained after the end of the intervention and at the same time, they were able to generalize to different environments and people they learned. In other words, it is seen that students with ASD learn the sense organs, which is one of the science subjects, together with the explicit instruction method presented with AR.

In the literature, it is suggested that students with ASD experience difficulties in science lessons because they do not have limited or verbal language skills, have problems in reading, exhibit behavioral problems, and cannot be included in the classroom discussion environment as well as teaching materials that are difficult to read (Patton & Bailey 2013, as cited in Sazak Pınar & Merdan, 2016). Another reason why students with ASD have difficulties in science lessons is that science lesson includes difficult, abstract and technical concepts and requires some thinking skills such as induction and deduction (Mastropieri et al., 2001; Patton & Bailey 2013, as cited in Sazak Pınar & Merdan, 2016). Therefore, students with ASD who cannot benefit from the existing educational opportunities like their normally developing peers need different arrangements and scientifically based systematic teaching practices in order to learn the target acquisitions (Kurt, 2006). In the light of this information, it is of great importance to try to teach sensory organs to students with ASD through AR application in this study.

Scientifically based practices are needed to maximize the current potential of children with ASD, whose number is increasing, and to meet their various needs. In particular, it is claimed that AR technology is suitable and useful for the learning styles of children with ASD and their interest in visual stimuli (Berenguer et al., 2020). In addition, it was revealed that many students with ASD were more willing and enthusiastic to learn when an AR application was used. Therefore, it was emphasized that AR application should be developed to draw the attention of students with ASD to mobile activities (Adnan, Ahmad, & Abdullasim, 2018). Additionally, technology-supported applications such as AR help teachers and parents to perform the mundane tasks and also enable them to be more creative and productive (Vullamparthi et al., 2013).

In the literature, it is thought that AR technology can be used as a promising option in teaching chain skills to students with ASD, and therefore, it can be seen as a reasonable application to be tried by teachers in practice (Cihak et al., 2016). In the study conducted by Cihak et al. (2016) using AR, the results showed that children with ASD independently performed the skill of brushing teeth, which is one of the chained skills. In addition, studies on teaching games and social skills to students with ASD using AR application are frequently encountered in the literature. For example; In the study conducted by Chen, Lee & Lin (2015), AR was found to be effective in teaching emotional expression and social skills to students with ASD. In a similar study carried out by Liu, Salisbury, Vahabzadeh & Sahin (2017), the AR was effective in teaching social skills to children with ASD attending inclusive. In the study conducted by Bai, Blackwell & Coulouris, (2014), it was revealed that AR was effective in teaching symbolic play skills to children with ASD. In their study, Lee, Chen, Wang & Chung (2018) used a combination of AR and concept maps to teach children with ASD the skills of greeting and using social cues when they met with their friends. In the study conducted by Lee (2020), it was observed that AR was effective in teaching various non-verbal social gestures by interacting with various virtual characters in teaching role-playing skills to children with ASD. In the study carried out by Wang, Zhang, & Cho (2020), the application called ¨Augmented Reality for Attention (MARA)¨ aimed to improve attention in adults with ASD through simple interactive visual activities. In other words, in the research, it is predicted that the objects used in daily life may interact with adults with ASD to develop attention management skills.

As in studies conducted using AR, follow-up data on persistence were collected in this study. maintenance (follow-up) data for this study were collected at 1, 2, and 3 weeks. According to the results of this research, it was observed that the students with ASD continued the behaviors they gained after the teaching of the sensory organs topic 1, 2 and 3 weeks later. Looking at the studies on AR applications, it is seen that Chen, Lee & Lin (2015) collected maintenance (follow-up) data 2 weeks later in their research with AR, Lee (2020) 6 weeks later, and Lee et al., (2018) 6 weeks later. On the other hand, it was revealed that Howorth, Rooks-Ellis, Flanagan & Ok (2019), Коломоєць (2018) and Silva, Fernandes & Grohmann (2014) did not collect maintenance data in their research with AR. According to the results of this research, the target skill acquired with AR application to students with ASD becomes permanent after the end of the intervention.

Another finding obtained in this study was that students with ASD were able to generalize their performances acrross environments and people, after the explicit instruction method presented with AR was implemented. In four different studies conducted by Howorth et al., (2019), Коломоєць (2018), Lee et al., (2018), McMahon et al., (2016) and Silva, Fernandes & Grohmann (2014), it is seen that no generalization study has been carried out in studies conducted using AR. The data on generalization allows the use of multiple examples of both materials and concepts, especially since it is not possible to have similar objects/objects for all students. It is of great importance to include the use of multiple stimuli in practice, especially for students with ASD who pay attention to only one feature of the stimulus in complex situations, that is, it has an overselective feature. For example; if addition skills is taught a student by using only certain cubes, a student may cause understand that addition can only be made with certain cubes. Therefore, using pens, balls or stones in addition to cubes in teaching activities with addition skills helps the student to fully grasp the addition skills. In summary, there is a need to conduct a generalization study with students with ASD by using different materials (Suhrheinrich et al., 2011/2019).

In conclusion, although the explicit instruction method presented with AR was effective in teaching sensory organs in this study. On the other hand, social validity data were not collected. Considering the limitation of this study, different skills can be taught with different disability groups by using AR application in the future research.

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