EFFECTIVENESS OF VIRTUAL REALITY ON TEACHING COMMUNICATION SKILLS TO STUDENTS WITH AUTISM[1]
OTİZMLİ ÖĞRENCİLERE İLETİŞİM BECERİLERİNİN KAZANDIRILMASINDA SANAL GERÇEKLİĞİN ETKİLİLİĞİ

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Abstract

The purpose of this study is to determine the effectiveness of virtual reality in teaching the ability to initiate and maintain communication to students with autism spectrum disorder. Multiple probe design across participants was used in the study. The intervention processes consist of baseline probe, daily probes, teaching, follow-up, and generalization sessions. 360-degree videos prepared for the analysis of communication initiation and maintaining skills were used in teaching sessions via virtual reality headsets. 360-degree videos were recorded using a 360-degree camera, and the videos were arranged by the researcher so that they can be watched on virtual reality headsets. Generalization sessions were organized as pre-test and post-test. The social validity data were collected from adult participants and a parent. The findings revealed that virtual reality is effective in teaching the skill to initiate and maintain communication. Results also revealed that students maintained these skills during the second, and third weeks and they were able to generalize these skills to different environments and to different people.

Keywords: assistive technology, autism spectrum disorder, communication initiating-maintaining skill, virtual reality

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Özet

Bu araştırmanın amacı otizm spektrum bozukluğu olan öğrencilere iletişim başlatma-sürdürme becerisinin kazandırılmasında sanal gerçekliğin etkililiğini belirlemektir. Araştırmada katılımcılar arası yoklama denemeli çoklu yoklama modeli kullanılmıştır. Araştırmanın bağımlı değişkeni, sanal gerçeklik ile sunulan öğretimin iletişim başlatma ve sürdürme becerisinin kazanım düzeyidir. İletişim başlatma-sürdürme becerisinin analizine yönelik hazırlanan 360 derece videolar araştırmanın bağımsız değişkeni olan sanal gerçeklik gözlüğü aracılığıyla öğretim oturumlarında kullanılmıştır. 360 derece videolar 360 derece kamera kullanılarak çekilmiş ve araştırmacı tarafından sanal gerçeklik gözlüğünde izlenebilecek şekilde düzenlenmiştir. Uygulama süreçleri başlama düzeyi yoklama, günlük yoklama, öğretim, izleme ve genelleme oturumlarından oluşmaktadır. Genelleme oturumları ön-test son-test biçiminde düzenlenmiştir. Ayrıca araştırmanın yetişkin katılımcılarından ve bir ebeveynden araştırmaya yönelik sosyal geçerlik verileri toplanmıştır. Sosyal geçerlik verileri toplama amacıyla yapılan görüşmeler yarı-yapılandırılmış görüşme şeklinde düzenlenmiştir. Araştırma bulguları OSB olan öğrencilere iletişim başlatma-sürdürme becerisinin kazandırılmasında sanal gerçekliğin etkili olduğunu, öğrencilerin öğretimi yapılan beceriyi birinci ikinci ve üçüncü haftalarda koruduğunu, öğretimi yapılan beceriyi farklı ortam ve kişilere genelleyebildiğini göstermektedir. Sosyal geçerlik bulgularında ebeveyn ve yetişkin katılımcıların görüşlerine göre sanal gerçekliğin becerilerin kazandırılmasında etkili bir araç olduğu, öğretim süreçlerinde zamanı kısaltabileceği öngörülmektedir.

Anahtar Kelimeler: yardımcı teknoloji, otizm spektrum bozukluğu, iletişim başlatma-sürdürme becerisi, sanal gerçeklik

INTRODUCTION

American Psychiatric Association (2013) defines Autism Spectrum Disorder (ASD) in DSM-5 as a neurodevelopmental disorder that occurs early periods of an individual's life and is characterized by lifelong impairments in social interaction and communication, and limited, repetitive behaviors, interests, or activities. To be diagnosed as ASD, these deficits must result in clinically significant impairments in social, occupational, and other domains. According to the DSM-5 diagnostic criteria, students with ASD experience limitations in initiating and maintaining reciprocal communication, understanding the other person's feelings and thoughts, as well as in non-verbal communication skills (making eye contact during communication, using gestures, and interpretation of gestures) due to their social-emotional responsiveness and social interaction deficiencies (American Psychiatric Association, 2013). According to the study of Ökcün-Akçamuş (2016) which was conducted to explore the social communication skills and language development characteristics of children with ASD, the development in the areas of non-verbal social communication, imitation, play, joint attention, verbal language, morphology/syntax, semantics, use of language are of great improtance for initiating and maintaining purposeful communication.

There exist many studies conducted to provide students with ASD with the skills necessary for social communication and interaction, and the teaching methods used in these studies vary. Mainly, methods such as group teaching (Kalyva and Avramidis, 2005), the use of clues and social reinforcement (Gena, 2006), teaching with role-play scenarios (Rutherford et al., 2007), social skill pack teaching (Leaf et al., 2009), peer intervention (Banda, Hart and Liu, 2010), environmental structuring in the natural environment (Güzel-Özmen, 2005), mutual intensive interaction method (Koyuncu, 2009) have been used and found as effective. Apart from these the picture exchange communication system has also been the subject of many studies (Tincani, Crozier and Alazetta, 2006; Rieger, 2004; Tincani, 2004).

Assistive technologies were utilized improve the quality of students' daily lives and to teach functional skills (reading and writing, social communication skills, study skills, cognitive skills) (Eliçin, Yıkmış and Cavkaytar, 2015; Çitil, 2016). Assistive technology is the equipment that can be obtained from the environment, changed or personalized, and benefited to increase, maintain or improve the functional capacity of individuals with disabilities (Johnston et al., 2007; cited in Alnahdi, 2014). It can be claimed that every tool that facilitates the daily activities of individuals functionally is a form of assistive technology. When the study conducted by Kızır and Yıkmış (2016) is examined, it is clear that previous studies on

the effectiveness of high-level technological devices such as tablet computers and other image providers (monitor, television) (Genç-Tosun and Kurt, 2014) in teaching children with ASD social skills have increased gradually in recent years.

Virtual Reality (VR) is a computer-human interface that can simulate a real environment, where participants can navigate in a virtual world, see, access and reshape this virtual environment, without the need to enter commands for the computer to do anything (Zheng vd., 1993). VR is a technology that enables the user to interact with the virtual environment (VE) that can respond to the user's reactions by bringing together two or more of the three-dimensional computer graphics, video applications, motion detectors, hardware and computer networks, which surrounds the user and can be designed according to the user's needs (Köse and Yengin, 2018; Steuer, 1992). It is thought that VR reduced the effect of distracting stimuli while providing VE interaction, and the interaction between the user and the environment increases the visual attention by separating the viewed image from the visual stimuli in the external environment.

Eight studies in which VR was used to teach students with ASD social skills were found. In the studies, it was observed that the VEs with which the participants interacted were created with computer graphics. It has been observed that these VEs were mostly included an application relying on computer graphics and different VR tool combinations are used to interact with the VE (Kandalaft et al., 2013; Beach and Wendt, 2014; Smith et al., 2014; Ke and Im, 2013; Didehbani et al., 2016; Lahiri et al., 2015; Trepagnier et al., 2011; Cheng et al., 2010). It has been observed that pre-test post-test and single-subject research models were generally used in the related studies. When the results of these studies are examined, it is safe to claim that VE is an effective tool in teaching social interaction and communication skills to participants with ASD. Significant findings were also found regarding the generalizability of communication skills taught by means of VR to different environments (Ke and Im, 2013; Smith et al., 2014; Beach and Wendt, 2014). In addition to creating virtual environments using computer graphics, 360-degree cameras produced in recent years can use dual lenses to capture environments in 360-degree video. When these images are viewed through VR glasses, users switch from their physical environment to a different environment; thus, they can be said to interact with VE (Ho and Budagavi, 2017; Youtube Creator Academy, 2019). Thus, instead of computer graphics, 360-degree environmental recordings are recorded through VR glasses, which allow the user to participate in a different and real environment.

Apart from these, no studies were found that examined the effectiveness of VR in teaching social skills to students with ASD. In addition, no studies were found that presented 360-degree real-life video footage using the VR glasses. Given the lack of studies in the literature and the lack of a study presenting 360-degree real-life footage using VR, the purpose was to examine the effectiveness of instruction provided using VR in teaching students with ASD the skills to initiate and maintain communication. To this end, the effectiveness of the instruction provided with VR was examined in terms of (1) teaching the ability to initiate and maintain communication to students with ASD; (2) sustaining the effectiveness of the instruction provided with VR in terms of the ability to initiate and maintain communication at the first, third, and fifth weeks after instruction; (3) examining the effectiveness of the instruction provided with VR in terms of students' ability to generalize this skill in different settings. It was also aimed to determine the views of parents of participants with ASD and adult participants in the study about the implementation process.

METHOD

Ethics committee approval: (Bolu Abant İzzet Baysal Üniversitesi Sosyal Bilimlerde İnsan Araştırmaları Etik Kurulu/26.02.2019/2019-86)

Research Design

In this study, the effectiveness of VR in teaching communication skills to students with ASD was investigated, and a multiple probe design across participants which is one of the single-subject research designs was adopted. This research model enables investigating the effect of the independent variable on the dependent variable with at least three participants, in addition to the permanence of the learned dependent variable (Tekin-İftar, 2018). After obtaining stable data for three consecutive sessions in the baseline sessions for the first student, the teaching sessions were initiated. During the teaching sessions, baseline data were started to be collected for the second student simultaneously with the first session in which the criterion was 100% for the first student. After obtaining stable data for three consecutive sessions in the teaching sessions for the first student, the teaching sessions were ended. During the teaching sessions for the second student, baseline data were started to be collected for the third student simultaneously with the first session in which the criterion was 100% for the second student. After obtaining stable data for three consecutive sessions in the teaching sessions for the second student, the teaching sessions were ended. Teaching sessions were ended after obtaining stable data for three consecutive sessions in the teaching sessions for the

third student. Follow-up sessions were organized in the first, second, and third weeks after obtaining stable data for three sessions in the teaching sessions of all three students.

Independent and Dependent Variables

The independent variable in the present study is the teaching practice conducted with a 360-degree video provided with VR headsets. The dependent variable is the teaching level of initiating and maintaining communication skills. The skill levels that are aimed to be acquired in the scenario prepared for the ability to initiate-maintain communication and the reactions of the teacher-adult participant to them are shown in Table.1.

Table 1. Skill Steps of the Scenario

*P: "*Student name*, can you take the class notebook and bring it to me?"*	8. "Sir, can I have the class notebook? he says.
1. "Okay teacher." he says.	A.P: "*Yes, you can.*"
2. He goes in front of the vice principal's door.	9. Takes the class notebook.
3. He clicks on the door.	10. "See you, teacher, have a nice lesson." he says.
4. Waits for the approval of the deputy manager.	A.P.: "*See you*, Student name, *have a nice lesson.*
A.P.: "*Come*"	11. "Thank you, teacher." he says.
5. He opens the door.	12. He goes to classroom.
6. "Hello teacher, how are you?" he says.	13. Gives the classroom notebook to his teacher.
A.P.: "*I'm fine,* student name, *thank you, how are you?*"	P: "*Thank you, you can go to your desk.*"
7. "I'm fine sir. Thank you." he says.	14. He says "OK teacher".

P: Practitioner; A.P.: Adult Participant; Numbered steps: the behaviors expected from the student.

Participants

The participants of this study are composed of three students with ASD, an adult who is a model (with a focused look) in the videos, and four adults (one practitioner, three vice principals) who communicate in the video. In the generalization sessions, the school counselors assumed the roles of the assistant principals involved in the scenario in the baseline and teaching sessions. For communication skills in student selection, certain prerequisite skills were sought for the use of assistive technology used in the research, as well as other additional skills. Regarding communication skills; maintaining eye contact for at least

10 seconds, the ability to verbally react to the communication initiated by the communication partner with a few words prerequisite skills were sought. For the use of assistive technology used; being able to follow the image provider (phone, tablet, computer, etc.) for at least 2 minutes and being able to use headphones, having figure-ground distinction, the ability of visual matching and visual classification; additionally; the ability to attend an event for at least 5 minutes; to be able to follow the given 2-step instruction, school attendance, prerequisite skills were sought. Students are coded with the names Kemal, Özcan and Can. Kemal is a 14-year-old male student with ASD. Özcan is an 11-year-old male student with ASD. Can is a 19-year-old male student with ASD. Özcan, one of the students with ASD, attended a special education class at a school during the study. Kemal and Can attended a special education practice school. Depending on the criteria considered in the selection of students, each student could make eye contact for about 10-15 seconds. They can respond to initiated communication with a few words. According to their teachers, they all spend time with tablet computers during the day. However, students had limitations in their communication initiation skills.

Environment

The sessions were conducted in 3 different schools because of the different schools the students attended in Bolu, Turkey. The classroom environment in which the intervention was initiated in all three students was arranged in the same way in terms of tables and chairs, and the light levels were adjusted to the required level. Sound and light levels were also arranged in the rooms of adult participants (vice principles). In the classroom settings, the practitioner and the students sat opposite each other in the corner of the classroom. In order for the students to get full efficiency from the 360-degree view, the distance between the tables and chairs has been adjusted depending on their right and left gaze. During the sessions, the classroom, the corridor between the classroom and the vice principal's room, as well as the vice principal's room were used for all three students, while the corridor between the classroom and the guidance counselor's room and the guidance counselor's room were used in the generalization sessions.

Tools

A 360-degree camera during the video preparation process, a helmet to fix the camera to the head, and a class notebook; computer, 360-degree camera, microphone, external sound card, and video & audio editing software were used in the editing process of the videos. VR

headsets, Bluetooth headsets, smartphones, action cameras, and class notebooks were used in the teaching sessions. A pen was used in generalization sessions.

Preparing the Videos

Three 360-degree videos for the script were recorded by an adult. Since 360-degree videos were recorded with a focused gaze (point-of-view), the communication model in the videos was determined by the sound recordings recorded during the editing process. The sound recordings were recorded by an adult in a studio environment and arranged to be heard in 360-degree video. Image depth and other adjustments were made during the video editing phase; video and audio recordings were combined. Privacy settings were done, and the videos were uploaded to a video sharing site, keeping it available only to the researchers. In Figure.1, sample images of 360-degree videos are included.

Figure 1. Sample images of 360-degree videos

Intervention

Baseline and Daily Probe Sessions

Baseline probe sessions were continued for at least three subsequent sessions until stable data was obtained. The data on the performance level of the students for the skill was collected using the single opportunity method. The practitioner instructed each student as "Go to the vice principal's room and bring me the classroom notebook". The students' reactions were monitored by the practitioner and adult participants (vice principals). In the daily probe sessions, the process was carried out as in the baseline probe sessions.

Teaching Sessions

The practitioner allowed the student to review the materials before starting the teaching session. Then "Student name, we will watch a video together with you using these headsets.

You need to watch and listen to the video carefully." He caught the student's attention to start the application. After getting the student's approval, he placed the VR glasses and headset on the student's head. The practitioner says, "I'm starting the video when you're ready." He said and started the video after getting the approval of the student. After the student's watching the video, he took off the VR glasses and headset. "Well done Student name, you watched the video very well." He reinforced his watching behavior by saying. Then "Come on Student name, now it's your turn, go to the vice principal's room and take the class notebook and bring it to me" and he watched the student performance. The skill steps followed by the student were reinforced; the steps in which he showed limitations in full and accurate performance were ignored. After the session ended, "Well done Student name, you participated very well; now you can swim in the ocean with your glasses!" He made him watch a 360-degree video. The requests of the students were taken into consideration in the selection of the 360-degree videos. The same process was followed in all teaching sessions.

Follow-up Sessions

They were conducted in the first, second, and third weeks after the teaching sessions. While follow-up sessions were planned to be conducted in the first, third and fifth weeks, they were held in the first, second, and third weeks, in case the education and training period was over. The follow-up session processes were maintained as in the baseline sessions. Following the follow-up sessions, students were shown 360-degree videos to reinforce their participation in the intervention.

Generalization Sessions

These sessions were organized in order to determine whether the students could generalize their achievements to different environments and people. Sessions were organized as pre-test and post-test. The students were instructed as "go to the counselor's room and take a pen and come". Then, the students were expected to go to the counselors' room and demonstrate the ability to initiate and maintain communication. Following the completion of the process, students' participation in the intervention was reinforced by letting them watch 360-degree videos.

Data Collection

Effectiveness data including probe, teaching, follow-up and generalization sessions, and social validity and reliability data were collected. The correct and incorrect responses by the

participants during the probe, teaching, follow-up, and generalization sessions were entered in the data collection form. Along with recording the responses in the data collection form, session processes were also recorded with a camera, and the data were cross-checked with the follow-up images. Participants' reactions were marked as correct responses (+) and wrong responses (-). In addition to collecting the effectiveness data by the researcher, data recording forms were also delivered to the adult participants (vice principal) of the study. Correct behavior percentages were calculated with the data recorded on the forms, and they were represented in a chart.

During the process of collecting social validity data, a semi-structured interview was conducted with the parent of the second student of the study with ASD (the interview was conducted with one parent because of the COVID-19 pandemic lockdowns) and adult participants (vice principals). To show the parent a video from the baseline probe session, a video from the teaching sessions, and a video in which the student performs the initiating and maintaining skill at 100% correct behavior level was selected. After watching the videos, information about VR was provided. Afterward, questions about the importance of the target skills, the performance levels before and after the intervention, and their views on the use of VR were asked. The answers were recorded upon receiving the participant's consent. The same procedures were completed with adult participants of the study without watching videos, and social validity data were collected.

Reliability

In the study, at least 30% of the data obtained for evaluation sessions and intervention sessions of all students were collected and analyzed for interobserver reliability. The observer was asked to watch the video recordings of the relevant sessions, and he was asked to record the data he obtained. The data obtained by the researcher and the observer were analyzed using the formula "Agreement / (Agreement + Disagreement) x100" (House, House and Campbell,1981). As a result of the analysis, inter-observer reliability data was found as 100% for all sessions.The intervention reliability data were recorded by the observer by watching the videos of the baseline probe, daily probe, teaching, follow-up, and generalization sessions. The observer recorded the planned responses and observed reactions of the researcher and the adult participants of the study in all sessions. Then, the observed response was divided by the number of planned responses and multiplied by 100 to calculate the intervention reliability data (Erbaş, 2018). While the intervention reliability was 93.75% in Özcan's teaching sessions, it was found as 100% for all students in all other sessions.

Data Analysis

The students' achievements for the dependent variable were shown on the line chart and the data were analyzed. The number of sessions was placed on the horizontal axis and the number of correct responses was shown on the vertical axis as percentages. The correct responses of the students to the 14 steps in the scenario for the dependent variable were expressed as percentages. Baseline session data were compared to the teaching session data; the data of teaching sessions were compared with the data of follow-up sessions with a view to determine the effectiveness of the intervention. The audio recordings taken for the purpose of collecting social validity data were written down by the researcher and analyzed.

Ethics Committee Approval

Bolu Abant İzzet Baysal Üniversitesi Sosyal Bilimlerde İnsan Araştırmaları Etik Kurulu/26.02.2019/2019-86

RESULTS

Findings Regarding Effectiveness

The chart in Figure 2 includes the baseline level of the impact of the intervention, the performance data for the intervention, and the follow-up sessions. The baseline level is shown in the B column, intervention in the I column, and follow-up data is shown in the F column. The baseline level, intervention, and follow-up session numbers are placed in the sessions line.
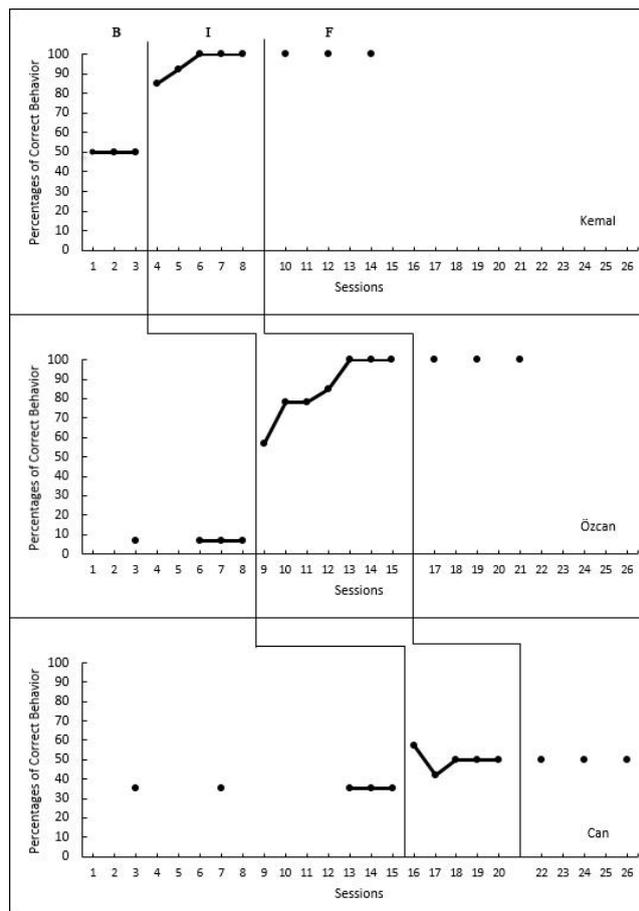
Figure 2. Students' Percentages of Correct Behavior in the Baseline Level, Intervention, and Follow-up Sessions.

It can be seen in Figure 2 that Kemal performed at the levels of 50%, 50%, 50% in the baseline sessions. His performance was at the levels of 85%, 92%, 100%, 100%, 100% in the teaching sessions. He performed at the levels of 100%, 100%, 100% in the follow-up sessions.

Özcan's performance in the baseline sessions were at the levels of 7%, 7%, 7%, 7%. In the teaching sessions his performance was at the levels of 57%, 78%, 78%, 85%, 100%, 100%, 100%. In the follow-up sessions he performed at the levels of 100%, 100%, 100%.

Can performed at the levels of 35%, 35%, 35%, 35%, and 35% in the baseline sessions. His performance in the teaching sessions was at the levels of 57%, 42%, 50%, 50%, 50%. It was found out that he performed at the levels of 50%, 50%, and 50% in the follow-up sessions.

Findings Regarding Generalization

The students' performances in the generalization sessions were presented in Figure 3. It can be seen in Figure 3 that Kemal and Özcan's ability to initiate and maintain communication in

their teaching sessions was observed at a performance level of 100% in the generalization sessions. It is seen that Can's acquisitions for the ability to initiate-maintain communication in teaching sessions was shown at a performance level of 50% in generalization sessions.
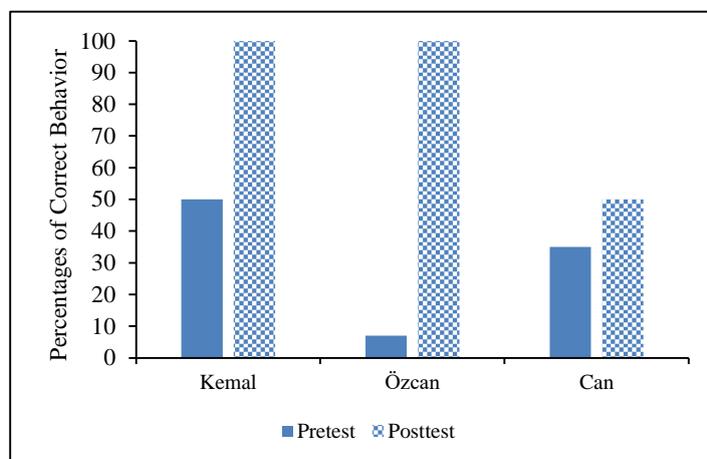
Figure 3. Percentage of Students' Ability to Generalize the Initiating-Maintaining Communication Skills to Different Environments and Participants.

Social Validity Findings

In his answer to the first question, Özcan's parent stated that he felt very happy that Özcan was able to perform a skill after the teaching practice, and that he found the results successful in his answer to the second question, and that the student was not so successful in this area of development before the teaching practice. In his answer to the third question, he stated that he found the effect of technology positive and that he thought that different skills could be taught with VR. In his answer to the fourth question, he thanked for the process.

In his answer to the first question, the adult participant (1) stated that the skill that is taught to the student is important for the student to communicate with his environment and increase his success, the adult participant (2) stated that this skill is an important life skill for the student, demonstrating the skill enables the student to feel as a part of the school; adult participant (3) stated that as a result of gaining communication skills at an acceptable level, the acceptance of the student by the society will increase, and he will be more willing and self-confident in social interaction and communication.

In his answer to the second question, the adult participant (1) stated that there were observable changes in the student's behavior; the adult participant (2) realized that he had just started his job at school, he did not know the student before, the student was alone in the school before the intervention, they had good communication with the student during the intervention

process and the student's self-confidence is raised, the intervention was helpful for the student; the adult participant (3) stated that the student established a result-oriented (taking the classroom notebook and leaving the room) communication, and if he could acquire the target skill at the desired level, it would have positive effects on the student.

In his answer to the third question, the adult participant (1) stated that by using VR in teaching processes, problems that may be encountered regarding time and space can be eliminated; the adult participant (2) realized that this technology was fun for the student and that using VR glasses was motivating; adult participant (3) stated that using technological developments in education had positive contributions to students, he thought that if the only basic level tools such as paper and pencil were used, the student would have limited participation in the study, the use of VR during the intervention was interesting, and the use of this technology would guide the field teachers.

In his answer to the fourth question, the adult participant (1) stated that reflecting the findings of such research to the educational processes in schools is important; the adult participant (2) was happy to participate in the study; the adult participant (3) stated that the topic of the study is important, the acquisition of communication skills in students with special needs is important, and shared positive opinions about the use of assistive technologies.

DISCUSSION AND CONCLUSION

The first finding of the study is that the education offered with VR is effective for the students with ASD in teaching the ability to initiate and maintain communication. When Can's effectiveness findings are analyzed, it is obvious that he showed an increased performance; however, this performance level had reached stability before reaching the desired level. Teachers and his parent stated that Can is quite interested in technological tools, he uses them in their daily lives and loved them. Can asked questions about the technological tools used, before the teaching sessions, it was clear that he was trying to understand how they work. When the findings of the study and this information were considered; it is thought that Can's focus on technological tools caused him to reach only a limited level of the target skills in the teaching sessions. However, when the data obtained from the baseline sessions and the data obtained from the teaching sessions were compared, the percentage of correct responses increased, therefore it can be concluded that the teaching practice presented during the intervention was effective. When the findings were examined, the effectiveness findings of teaching practice created and presented with computer graphics show consistency with the studies adopting the teaching practice presented with 360-degree video recordings using VR

headsets for students with ASD to acquire social skills (Cheng et al., 2010; Trepagnier et al., 2011; Kandalaft et al., 2013; Ke and Im, 2013; Beach and Wendt, 2014; Smith et al., 2014; Lahiri et al., 2015; Didehbani et al., 2016).

In related studies, it has been observed that VEs are created with computer graphics. In this study, however, the VE was created by recording the real environment with a 360-degree camera. According to Rao and Gagie (2006), the use of visual materials and learning by experience were important in the learning process of students with ASD. According to Kayabaşı (2005), arranging the teaching environments with VR provides students with the opportunity to experience the situations and feelings that they are not possible for them in real life, and makes it possible to learn by doing and experiencing by means of offering them the opportunity to learn in the VE. The VE created in the study enabled students to have a 360-degree viewpoint by enabling them to interact with this environment using head movements, the use of real environment images while creating the VE increased the feeling of being in the real environment. Based on this, it can be stated that the teaching practice gives students with ASD the feeling of being in a real environment and enables them to achieve their target skills by doing and experiencing this sense of reality, it is thought that presenting the real environment through VR headsets by allowing 360-degree interaction with head movements makes the teaching practice effective.

Another reason for the effectiveness of the application is thought to be the combination of VR equipment used in a way that eliminates the distracting visual and auditory stimuli. The use of VR headsets enabled the students' field of vision to be separated from the outside environment. Thus, it is thought that it enables them to direct their attention to the 360-degree video and social interaction established within the scenario. The use of headphones is thought to get rid of the auditory stimuli that may come from outside of the virtual learning environment and direct their attention to social interaction in the scenario. Considering that attention skills are important for the successful establishment of social interaction and communication (Durukan and Türkbay, 2008), it is an important factor to eliminate the visual and auditory stimuli that may be distracting using the combination of VR tools as in the teaching practice, accordingly, it can be concluded that the selection of this combination was also effective in teaching the initiation and maintaining communication skills to the students.

The second finding of the study is the ability of students to maintain the initiation and maintaining communication skills, which is offered to the students in the study by means of VR, in the first, second, and third weeks after the education is completed. When the follow-up

findings are analyzed, it is obvious that the participants preserved their gains in the first, second, and third weeks after the completing of the teaching sessions. Accordingly, the findings regarding the permanence of the teaching practice showed similar results to the other studies in the literature which aimed to determine the permanence of the acquisitions as a result of the follow-up sessions (Ke and Im, 2013; Cheng et al., 2010).

It is thought that one of the reasons why the practice is effective in maintaining the acquired skill in the first, second, and third weeks is that VE was created with 360-degree real image recording. Considering the importance of learning by doing and experiencing for the students with ASD (Rao and Gagie, 2006) and that they feel like they are in the real environment during the teaching sessions is thought that transferring the real environment to the VE to protect the acquisitions they achieved and conduct the learning process in the same environment both within the VE and in the school environment enables the students to remember the process in their school life outside the intervention process of the information they have learned before, and they protect their gains.

The third finding of the study was the finding that students can generalize their acquisition of the skills to different environments and people. When the generalization findings are examined, it was found out that Kemal and Özcan can generalize the newly gained skills to other environments and other adult participants at the level of 100%, while Can's correct behavior level was 50%. This finding of the study is consistent with the generalization findings of related studies (Beach and Wendt, 2014; Smith et al., 2014).

Similarly, it was found out in the study that Özcan's parent had positive opinions about the teaching practice offered with VR in acquiring the ability to initiate and maintain communication. It is thought that the gap because of the lack of social validity purposes of the related studies will be filled with this study. The fifth finding of the study is the positive opinions of the adult participants (vice principals) of the study about the teaching practice offered with VR regarding the acquisition of the ability to initiate and maintain communication. Adult participants stated that VR can be used as a teaching tool, children with ASD can interact socially with the teaching of initiation-maintaining communication skills, and the use of VR in teaching processes will have positive effects in terms of time and environment.

During the research process, it was observed that Kemal did not act fluently after he stood up to follow the instructions given in the baseline sessions. It was noted that the time elapsed between standing up from his chair to fulfill the instruction and going to the door of the vice

principal's room in the baseline sessions was halved compared to the time spent in the evaluation stages of the fourth and fifth teaching session (30-15 seconds). It was observed that Kemal acted more fluently in order to fulfill the task given in the teaching sessions, accordingly; it is thought that he started to fulfill the given tasks more willingly. It is thought that the teaching practice offered with VR makes the teaching process interesting for the student and increases the desire of the student to participate in the teaching practices in order to gain the ability to initiate-maintain communication.

While Kemal and Can could go to the vice principal's room in the baseline level sessions, it was figured out that Özcan showed limitations, but in the evaluation conducted at the end of the first teaching session, it was seen that he went to the office of the vice principal. Again, in the baseline sessions, it was observed that he ran down the corridor after leaving the classroom to follow the instructions. However, after the fourth teaching session, it was observed that this behavior disappeared and moved at an acceptable speed. Teachers also reported that this behavior decreased after the intervention, and now he moves more slowly in the school. According to this finding, it is safe to claim that the student learned about the location of the deputy principal's room, which is one of the parts of the school, VR is also thought to be effective for the teaching of the parts of the school, and the student's running behavior in the school decreased, thus, it is thought that the possibility of harming himself is decreased.

As a result, this study revealed the effectiveness of VR in providing ASD students with initiate-maintain communication skills. When the findings regarding the first purpose of the study were considered, it was found that VR was effective in providing students with ASD the initiate-maintain communication skills, when the findings for the second purpose are examined, it can be concluded that the initiation-maintaining communication skill acquired by students with ASD through VR continues to be maintained during the first, second, and third weeks after the teaching ends, and thus it can be claimed that permanence is achieved. When the findings for the third purpose are examined, it can be concluded that students can generalize the acquisitions they obtained to other environments, situations, and people.

It was observed that two students rubbed their eyes as soon as they take off their VR glasses in the teaching sessions, and the students stated that they felt dizzy. However, this situation was not observed in the ongoing teaching sessions, and one of the students also stated that he was not feeling dizzy anymore. From this point of view, it is thought that doing exercises before using VR glasses for instructional purposes can eliminate negativities such as

dizziness. In addition to these, the problem behavior of one of the students (running in the corridors) disappeared during the application process, therefore research on the effect of VR on some problem behaviors can be conducted, one of the students learned the place of the adult participant's room in the school during the teaching process, it can be concluded that other studies can be designed to examine the effect of VR on spatial learning. Another student's intense interest in technological tools is thought to be related to his inability to acquire the desired skill level in the application process. It is thought that further studies can be conducted to find out the effects of the interests and attitudes of students with ASD or other special needs towards technological tools on the teaching processes conducted with technological tools.

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