Effectiveness of Tablet Computer Use in Achievement of Schedule-Following Skills by Children with Autism Using Graduated Guidance

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Abstract

Tablet computers are frequently used in the education of children with autism. Studies show that educational activities involving tablet computers have positive effects on the acquisition of target skills by children with autism. In this research, the effectiveness of the use of tablet computers in teaching children with autism to use schedules was evaluated. Three male students of ages 5 to 7 diagnosed with autism participated in the research. A single-case multiple-probe-design-across-participants was used in the research. Independent variable of the research was the education provided via tablet computers using the graduated guidance technique, and the dependent variable was the acquisition of schedule-following skill. Follow-up and generalization data were collected on the 7th, 14th, and 21st days after the teaching sessions ended. Follow-up sessions were completed with 100% performance for all three subjects. Generalized correct responses were found 90% for one subject, and 100% for the other two. The results indicated that the subjects acquired, maintained, and generalized the schedule-following skills after the teaching sessions completed. In addition, the teachers of the subjects were asked their opinions about the application. These opinions that form the social validity data of the research support the research findings.

Introduction

Activity schedules were developed by Lynn McClannahan and Patricia Krantz at Princeton Child Development Institute-PCDI in United States of America (USA). Activity schedules is a visual support system that consists of prompts like sets of words or pictures for the individual to perform a chain of activities (McClannahan & Krantz, 1999). Activity schedules can be prepared with photos, pictures, and texts. While activity schedules can be presented to the individual in a way that the activity steps are described in detail about how a skill can be performed, they can also be prepared only to provide prompts to the individual for beginning the activity (McClannahan & Krantz, 1999). For activity schedules presented in the form of folders, there are several skill steps. First, the practitioner puts activity pictures on each page. Then, the student takes the material related to the picture after the practitioner presents a prompt, completes the activity in the picture, and puts the

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material back. Finally, the student returns to the schedule, turns the page, and advances to the next activity (Mathewson, 2010).

Schedules are frequently used to teach leisure, play, and daily life skills to children with autism. Performing skills independently and making choices are essential for children with autism, and schedules are very suitable education sets for building these skills. It is seen in the literature that schedules were generally used in book format (Brayn & Gast, 2000; Betz, Higbee, & Reagon, 2008; Blum-Dimaya, Reeve, Reeve, & Hoch, 2010; Çuhadar & Diken, 2011; Detmer, Simpson, Myles-Smith, & Ganz, 2000; Hall, McClannahan, & Krantz, 1995; Krantz & McClannahan, 1993, 1998; Krantz, MacDuff, & McClannahan, 1993; MacDuff, Krantz, & McClannahan, 1993; Massey & Wheeler, 2000; Stevenson, Krantz, & McClannahan, 2000; O'Reilly, Sigafoos, Lancioni, Edrisinha, & Andrews, 2005; Watanabe & Sturmey, 2003). When existing studies are examined it is seen that activity schedules are effective for increasing on-task behavior of children who show autistic characteristics (Brayn & Gast, 2000; Massey & Wheeler, 2000; Watanabe & Sturmey, 2003), for decreasing problem behavior (Detmer et al., 2000; O'Reilly et al., 2005), for increasing peer interaction (Betz et al., 2008), for learning play skills in the activity schedule (Blum-Dimaya et al., 2010), for learning leisure time skills (Çuhadar & Diken, 2011), and for learning daily life skills (MacDuff et al., 1993). It is also seen that the information about the collection of effectiveness data related to the skills taught in these studies is very limited. Therefore, new activity schedule teaching studies in which new skills like academic, social, and communication skills are taught and data related to these skills are systematically collected are needed (Banda & Grimmet, 2008).

In a research by Carlile, Reeve, Reeve, and DeBar (2013) activity schedules were used via iPod Touch devices to teach leisure skills to children with autism. Four children of ages 8 to 12 with autism participated in that research. In the research, an iPod Touch device, which can be used as a personal digital diary, was installed with a picture activity schedule designed by the researchers for the children to spend their leisure time. Practice sessions of the research were conducted using graduated guidance technique. Practice sessions were 1 to 3 times a day, and each activity lasted 2 minutes. Pictures of activities like basketball and pinball were put into the picture activity schedule on the device. A single-case multiple-probe-design-across-participants was used in the research. Research results show that all subjects reached a high level of success at the end of the practice, and that their success was persistent. Follow-up data were collected 2 weeks, 1 month, and 3 months later after the teaching sessions ended. Two subjects exhibited 100% success, while the other two exhibited 80% and 90% success respectively during the follow-up sessions.

In addition to activity schedules, multiple learning environments created using technology are taking place of conventional methods and tools in the education of children with autism (Bölte, Golan, Goodwin, & Zwaigenbaum, 2010). When the studies related with the use of technology in the education of children with autism are examined, the use of computer-aided education is generally seen (Ramdoss et al., 2011).

Technology-aided education applications have become more common than ever in educational life of children with autism. Studies performed with tablet computers, which fall into high-technology device category, are very effective for children with autism, as well as other computer-aided studies. Results of the studies performed with tablet computers show that children with autism can accomplish the expected skills especially by using their fingers on the touch-screen of tablet computer more easily and intuitively than moving mouse pointer on the computer screen (Whalen, Liden, Ingersoll, Dallaire, & Liden, 2006).

In the literature, there are several studies that have performed applications which require high-technology for children with autism to improve speaking skills (Achmadi et al., 2012), to teach chained tasks (Ayres, Maguire, & McClimon, 2009), to teach daily living and vocational skills (Bereznak, Ayres, Mechling, & Alexander, 2012), to teach social problem-solving skills (Bernard-Optiz, Sriram, & Nakhoda-Sapuan, 2001; Hopkins et al., 2011; Hourcade, Bullock-Rest, & Hansen, 2012), to teach leisure skills (Carlile et al., 2013), and to teach communication skills (Hetzroni & Tannous, 2004). In addition, there are other studies using technology-aided activity schedules to develop leisure and play skills of children with autism (Carlile et al., 2013; Dauphin, Kinney, & Stromer, 2004).

Children with autism have usually difficulty with discriminating emotional information and have problems with focusing. Since education presented via a computer presents only the necessary information, this can help them solve their focusing problems. Moreover, children with autism see the world complex and unpredictable, therefore they have difficulty with coping with change, and they cannot easily predict what to do next. Use of a computer, however, provides consistent, predictable, and repeatable responses (Hayes et al., 2010; Silver & Oakes, 2001). Besides, when compared to verbal prompts, visual tables help reduce the dependence on adult support, thus allowing independence, and improve on-task behavior (Hitam et al., 2011).

In a compilation study performed by Pennington (2010), studies implemented with children with autism by using computer technology were examined. In that study where fifteen studies were evaluated, it was shown that computer-aided education was an effective application for acquiring, generalizing, and maintaining the target skills. It was also emphasized that with the advancing technology, technological tools that could easily be carried and used like laptop computer, iPad, iPod, and TouchPad should be utilized in the education of children with autism (Hourcade, Bullock-Rest, & Hansen, 2012).

Teaching with graduated guidance technique was used in the teaching sessions of the current research. Graduated guidance is an effective technique for teaching children with autism. First used by Foxx and Azrin (1973), with graduated guidance, which is an errorless teaching method, practitioners provide a controlling prompt and then gradually remove the prompt during a teaching activity (Wolery, Ault, & Doyle, 1992).

In teaching with graduated guidance, which is especially used for teaching chain behaviors to children with autism, the prompt is faded out in terms of its intensity. Teaching is generally started by providing the physical prompt first, and then its intensity is reduced gradually. For example, for teaching a target skill, the prompt is provided in the following order: first, the physical prompt, then, partial physical prompt, and finally, being a shadow. Here, it is up to the personal decision of the practitioner when the prompt is faded out. That is, the practitioner begins to fade the prompt depending on the performance of the subject, and if the subject responds incorrectly, the practitioner returns back to the previous prompt level.

There are several researches in the literature showing that studies implemented using activity schedules with children with autism are effective for children with autism to acquire several skills (Brayn & Gast, 2000; McClannahan & Krantz, 1999). Additionally, it is seen that studies involving the use of activity schedules on portable devices give effective results (Carlile et al., 2013). When the studies in the literature are examined, it is seen that there are a limited number of research where activity schedules are used on portable devices by children with autism. In a study by Hileman (1996), children with autism are motivated by computers because computers provide predictable and consistent environment when compared with humans whose responses can be unpredictable by nature. In addition, computers do not send social messages that are confusing to children with autism. In another study by Jordan (1995), computers are found to be effective at increasing focused attention, overall attention span, fine motor skills, generalization skills (when compared to non-computer activities), and decreasing problem behaviors and self-stimulatory. Besides, in addition to leisure skills, children with autism need to use their class hours effectively, which is one of the main

motivations of conducting this current research. This study therefore addresses the following research questions:

- Is the schedule program provided via a tablet computer using graduated guidance effective for children with autism to acquire and maintain the schedule-following skill?
- Is the schedule program provided via a tablet computer using graduated guidance effective for children with autism to generalize the schedule-following skill?
- What are the opinions of the teachers of the subjects regarding the schedule-following skill taught via a tablet computer software using graduated guidance?

It is believed that the findings of this research will serve as a guide to both practitioners and researchers in the field. Furthermore, the software program used in the research is freely available for use on mobile devices with Android operating system, and this can be regarded as another output of the research.

Method

Participants
Subjects

Three male students of ages 5 to 7 diagnosed with Autism Spectrum Disorder (ASD) participated in the research. The subjects had attended an institution providing education and rehabilitation for children with special needs, located on the European side of Istanbul, Turkey, for 2 to 3 years. They had not attended any other educational institutions. During the selection of subjects for the research, decision was made among several available students with similar prerequisite skills by considering their class hours.

Ali is a 5-year old male student diagnosed with ASD. Ali can construct sentences with 3-4 words, follow instructions given to himself, and recognize digits. He has been attending the education institution 3 days a week for 2 years. Bora and Cem are male students diagnosed with ASD, of ages 6 and 7 respectively. Both can communicate with a limited number of words. They can follow instructions given to themselves without needing prompts, and recognize digits. Cem is also literate. They both have been attending the education institution 3 days a week for 3 years.

Subjects of the research were carefully decided among seven students with similar prerequisite skills according to their class hours. Those prerequisite skills expected from the subjects were (a) ability to distinguish shape/background, (b) ability to follow instructions, and (c) ability to receive physical prompts. Ability to distinguish shape/background was required because the subjects needed to distinguish pictures and texts provided on the tablet computer and therefore to make correct selections on the tablet computer. Ability to follow instructions was expected because the subjects needed to understand and follow the instructions given by the tablet computer program. Finally, ability to receive physical prompts was necessary because the subjects needed to allow the graduated guidance technique that would be used by the practitioner during the teaching sessions of the research. These prerequisite skills determined by the first author were also evaluated by an expert with a PhD in special education. Furthermore, among these prerequisite skills, ability to distinguish shape/background was regarded as the most essential one (McClannahan & Krantz, 1999). In order to check the eligibility of the subjects to the research, an evaluation was performed by the practitioner. For the ability to distinguish shape/background, the subjects were shown five cards with the pictures of pencil, computer, table, baby doll, and flowerpot, and they were asked to tell the objects seen in the pictures on the cards first. Then, they were asked to show the cards with the pictures of the objects told. The practitioner identified several instructions and asked the subjects to follow them. These instructions decided by the practitioner were throwing rubbish into the rubbish bin, tidying up the study table, closing the window, and putting the toys into the toy basket. In order to evaluate the ability to receive physical prompts, the practitioner practiced the exercise of turning the desktop computer on and off with the subjects by providing full physical prompts, and examined how much physical prompt they were open to receive.

Researchers

There were two researchers and one practitioner in this research. The first researcher had a PhD in special education. She had one year of one-to-one work experience with children with autism, using the activity schedules developed by McClannahan and Krantz (1999). After having worked with the original form of activity schedules for a long time, she developed the research question whether the activity schedules used effectively in the education of children with autism would also be effective when used on portable devices like tablet computers.

The second researcher had a PhD in computer science, and had a broad experience with software development for mobile devices, especially on Android platform. He developed the tablet computer software used in this research after he worked with the first author about the user interface details, other requirements, and the use-cases of activity schedules.

The practitioner of the research had six years of teaching experience with children with autism. In addition, she was a practitioner who had worked with activity schedules in the original form for a long time. She was given detailed briefs by the first author about how the activity schedule software could be used on tablet computers. Then, she performed the application sessions of the research.

Observers

In order to collect inter-observer agreement and treatment fidelity data for 30% of the teaching sessions of the research, there were two observers. Both of the observers were the special education teachers of the subjects where they had been taking education.

Settings

The research was conducted in the subjects' very own individual classrooms of their educational institution. There are one study table, two chairs, one bookshelf, and one blackboard in the classrooms which are of size 2m x 3m. No special arrangements for the research were made in the classroom layouts.

Materials

Tablet Computer and Software

In general, a tablet computer, or simply a tablet, is a compact and lightweight mobile computer with display, computing unit, and battery put in a single unit. Surface of the display unit of modern tablet computers is sensitive to finger touches, thus finger gestures replace conventional computer mouse and keyboard.

A software program that runs on tablet computers was specifically designed and developed for this research by the authors, and this program was used during the sessions. The schedule constructed for the research was inspired by the activity schedules used in the education of children with autism. Besides, the studies of Carlile et al. (2013) who used activity schedules on iPod Touch devices encouraged the authors to create a software that runs on tablet computers.

The program was designed by considering the activity schedule application steps developed by McClannahan and Krantz (1999). The application steps of the activity schedules designed were first created by the first author as simple draft drawings on an MS Word document. These application step designs were presented to two experts with PhD's in the field of special education for their examination and review. According to the expert opinions, the design of the activity schedule software had similar application steps with the original activity schedules, and the only difference was in the way the schedules were presented. Therefore, it was not necessary to make any changes in the design. After the design step, the actual program was constructed by the second author. While constructing the software interfaces, special attention was paid to make sure the software was appropriate for repeated practice, new activities could easily be added, and completed activities could easily be removed. Finally, the activity steps designed for the target behavior were transferred to the tablet computer program and made available for use on the tablet.

In this research a 7-inch tablet computer with Android 4.1 operating system installed was used. The program was installed and configured on the tablet. The program allows creation of unlimited number of activities with unlimited number of steps. Activities can have an associated picture and a title describing the activity. In addition, steps of the activities can have an associated title, picture, and audio clip, as well. Practitioner can use previously stored pictures from the gallery of the device, or can create pictures by taking photo using the internal camera of the device, if the device has a built-in camera, which is the case most of the time with modern tablets. Practitioner can also use previously stored audio clips from the gallery, or can record associated audio clip using the built-in microphone of the device if the device has one.

There are two buttons on the main screen of the program. One is "Create Activity" button, and the other is "Do Activity" button. The "Create Activity" button is for the practitioner to create the steps of the activity to be practiced. For example, the steps of teeth-brushing skill can be photographed with the tablet computer and these photos can be imported from the memory of the tablet to the program as the visuals of the steps. Here, it is possible to add activity steps, change their orders, and remove them. In addition, using the program settings screen, which is not accessible via a button on the main screen but via the menu options of the program, it is possible to turn audio, visual, and text prompts on and off. The "Do Activity" button is for the subjects. Steps of the activity designed by the practitioner are provided to the subject as a combination of audio, visual, and text prompts depending on the practitioner's configuration settings. The subject can tick a tick box after he completes each activity step. If the activity is created with visuals, the subject swipes the screen from right to left to advance to the next step; otherwise, he just ticks the tick boxes provided as list view of the steps.

In this research, the puzzle activity was chosen for teaching the subjects to use schedules. The subject touches the name of the puzzle activity from the list of activities available to begin the activity. A sample screenshot that shows the list of activities on the tablet computer program is given in Figure 1. The first step of the puzzle activity with a picture prompt is also shown in Figure 2.

The table computer software was specifically designed that it can provide audio, visual, or text prompts for the activity steps. In the settings screen of the program, there are three configuration items that can be turned on or off depending on the practice purpose. These items are audio, picture, and text. If the practitioner activates the audio setting, the steps to be followed by the subject in the activity can play the related audio clip like "Take the bag number one!" If the audio setting is deactivated and text setting is activated only, then the instructions related to the activity steps appear as a list of text items. Another possible usage can be with only visual prompts where the instructions are pictured and provided on the tablet screen with only the pictures. For example, the photograph containing the moment when the bag number one is taken from the puzzle container can be put on an activity step. Audio setting can also be activated along with the visual setting. That is, it is possible to play the related audio clip by touching the picture of the activity step.

The practitioner can use any combination of prompt settings depending on the level of the subject. For example, it is possible to deactivate the text setting and get only audio and visual prompts, or it is possible to deactivate the audio setting and get only text and visual prompts, or it is possible to deactivate both the text and the audio setting to practice only with visual prompts. It is also possible to follow a schedule with only audio or only text prompts. In this study, since one of the subjects (Cem) was literate, the text and visual settings were activated for him. However, for the other subjects (Ali and Bora), the audio and visual settings were activated for them to follow and do the activity steps.

When the subject completes a step, he touches the tick box below the picture and swipes the screen from right to left in order to advance to the next step. This swiping gesture is a very natural movement for interacting with the tablet computer and is a very common way of navigating among a sequence of items like pages, pictures, and so on. If the subject touches on the picture associated with that step, an audio clip is played if there is an associated audio clip with that step. After all steps of an activity are completed, the subject uses on-screen navigation or the back button of the device to return back to the list of activities.

Other Tools and Materials

Besides the tablet computer and the software, data sheets and pencils were used for recording data related to the application process in the research. In addition, a video camera was used for recording the application, and then for obtaining inter-observer agreement and treatment validity data. Finally, a desktop computer was used for watching the video recordings and analyzing the research findings graphically.

Dependent Variable

Dependent variable of the research was the subjects' acquisition level of schedule following skill. The target skill was defined in detail as the following steps, and it was evaluated on a pragmatic basis: (a) selecting the tablet computer program, (b) touching the picture of the activity and receiving the instructions (text/audio/visual), (c) taking the practice box with the same picture as the activity from the shelf, (d) putting the activity onto the table, (e) taking the content of the box out, (f) swiping the tablet computer screen from right to left to see the next step, (g) listening to/reading/seeing the current step on the screen, (h) doing the current step, (i) completing the activity, and (j) putting the activity box back to its place.

Independent Variable

Independent variable of the research was the education provided via tablet computers using the graduated guidance technique.

Definitions of Possible Responses

Possible responses expected from the subjects were identified as (a) correct response, (b) incorrect response, and (c) unresponsiveness. Since graduated guidance technique was utilized in the research, the subjects were reinforced for their correct responses, and when they emitted incorrect response or stayed unresponsive, the practitioner decided to change the type of the prompt she provided. For example, when the type of the prompt was holding the wrist or elbow of the subject and the subject emitted incorrect response or stayed unresponsive, the practitioner returned back to the full physical prompt level.

Experimental Design

A single-case multiple-probe-design-across-participants was used in the research. This is a research model where effectiveness of a single independent variable is evaluated on three different subjects (O'Neill, McDonnell, Billingsley, & Jenson, 2011). In this model, experimental control was obtained by having a change in the data levels or tendencies of the first subject with whom the activity schedule application was begun, and by having similar changes in the data levels or tendencies of the second and third subjects for all situations as they involved in the application over time. There are several factors that can threaten the internal validity of single-case research models. In order to have internal validity, observed changes in the dependent variable must be caused by only the independent variable. Therefore, the research must be designed in such a way that all factors other than the independent variable can be controlled. The threatening factors in this model are (a) external factors, (b) testing, (c) experimental mortality, (d) change in the data, (e) artificial environment effect, (f) treatment fidelity, and (g) maturation (Tawney & Gast, 1984).

In order to control external factors, the families and the teachers of the subjects were warned that the skills used in the research must not be taught to the subjects. Measurement related threats were avoided by recording the sessions with a video camera and by collecting inter-observer agreement and treatment fidelity data from these recordings. In order to prevent experimental mortality in the research, contracts were signed with the families of the subjects, which stated that the families would bring their children to school during the implementation. As a precaution against data change threats, the practitioner planned to extend the teaching time in order to obtain stable data. Artificial environment effect is caused by performing or observing the implementation of the research out of the places where daily life of the subject usually takes place (Tawney & Gast, 1984). To avoid this threat, practice process of the research was implemented at previously prepared environments at the institution where the subjects took education. In order to have the treatment fidelity under control, treatment fidelity data were collected for 40% of the sessions. Maturation is that as a specific period of time passes during the implementation process of the research, biological, emotional, or mental maturity of the subject affects the dependent variable (Tawney & Gast, 1984). The researchers predicted that the teaching sessions would be completed in a time period that this threat could not happen. In addition, this model did not require that all subjects study together, therefore there was no such possibility that the subjects would be affected by each other.

General Procedure

Main goal of this research was to evaluate the effectiveness of using tablet computers for teaching schedule-following skills to the subjects using graduated guidance technique. In order to achieve this goal, the general procedure followed consists of Baseline and Full Probe Sessions, Teaching Sessions, Follow-up and Generalization Sessions, and Social Validity phases.

Baseline and Full Probe Sessions

The first one of the full probe sessions of the research was performed to obtain the baseline. In the baseline probe session, the levels of schedule-following skills of the subjects were evaluated. In this session, the schedule prepared on the tablet computer was put on to the study table of the subject and then the subject was tested with the verbal instruction "Begin the activity" by the practitioner. The other full probe sessions of the research were performed to find out the subjects' acquisition levels of the target skill and the success status across subjects. The evaluations in these sessions were also like the baseline probe sessions.

Teaching Sessions

Teaching sessions of the research were performed 3 days a week. The research was implemented within class hours at the institution where the subjects took education. In about the first 30 minutes of the 45-minute class hours, the subjects performed the target skill, and then they were interested in different activity rewards given by the practitioner for the rest of the time. These rewards were different for each subject. For example, playing with the toy ambulance, playing with play dough, and throwing ball to the basket with a basketball were among the rewards.

During the teaching sessions, the practitioner used the "+" sign for the steps the subject performed independently, and used the "-" sign for the other types of responses. At the end of the session, the performance of the subject was calculated as a percentage considering the steps the subject performed without any help, and marked on the data chart.

For teaching to use activity schedules, teaching a leisure skill would be an appropriate choice. First of all, the courses that the subjects were taking at their educational institution were examined and evaluated. After the evaluation, the activity to be used in the research was selected by considering the class hours when the subjects attended the institution. Since practice hours were not convenient for transition between activities, application of the steps of a single activity that was on the program of all the subjects was found more suitable. IEP (Individualized Education Program) of each subject was carefully inspected and the puzzle activity that was on the program of each subject was decided for the research. The puzzle selected was not one of the completed puzzles before, instead a puzzle was

selected from the puzzles waiting to be used in the subsequent teaching sessions. The selected puzzle was a 12-piece one, and it had not been practiced before. The practitioner transferred the steps of the puzzle to the tablet computer once, and did not repeatedly change the steps for each subject. This saved time for the practitioner while implementing the research because she did not need to change the steps every time she worked with a new subject.

Steps of the puzzle activity were prepared on the tablet computer with the same program in order to teach the subjects to use schedules. The pieces of the actual puzzle selected for the research were put into plastic bags as 4-piece packs. These plastic bags were numbered 1 to 3. For example, the 4 pieces that formed the bottom row of the puzzle were in the bag numbered 1. Similarly, the whole puzzle was divided into total 3 bags containing the rows of the puzzle from bottom to up respectively. The photo of the complete puzzle was put on the plastic container where the plastic bags were contained in, and the same photo was used as the activity icon on the tablet computer program. This way, the subjects could easily select the correct activity seeing its image on the program, and then they could take the plastic container with the same image.

The program's design allows the subjects to follow a sequence of steps while providing audio and visual prompts. These prompts were removed gradually during the application phase according to the performances of the subjects. In the teaching sessions, the practitioner gave the vocal instruction "Begin the puzzle activity.", and subjects were expected to select the puzzle activity among the existing activities on the tablet computer, to take the same material as seen on the screen from the shelf of the activity materials closet, to put the puzzle onto the table, to follow through the puzzle assembling steps on the tablet computer to assemble the pieces of the puzzle, to tick the tick boxes of the steps when they completed each step, and finally to put the puzzle back to its place on the activity materials closet. After the subjects selected the activity on the tablet computer program, they took the bags numbered 1, 2, and 3 respectively. Since all the subjects could recognize digits, it was decided to put numbers on the plastic bags. The subjects were not allowed to skip to the next bag without putting all the pieces in one bag together. The subjects took each puzzle row according to the tablet computer instructions, and they finally completed the puzzle by adding each row over the existing one.

When the subjects exited the tablet computer program, the ticks of the activity steps were automatically cleared by the program, and then the program became ready to use again. Once the subjects emitted the previously mastered response independently and correctly, their preferred snacks were delivered as a reinforcement. After the teaching sessions of each subject ended, follow-up and generalization data were collected.

In this research, although the subjects had done no prior practice with tablet computers, they were not taught anything about tablet computer usage. Since teaching with graduated guidance was applied, when the practitioner provided physical help, the subjects directly learned how to use the program on the tablet. The practitioner let the subjects do all the activity steps with physical help first. These steps were as follows: opening the program on the tablet, selecting the next activity to do from a list of activities on the screen, taking the box related to the selected activity from the shelf onto the table, following the correct order of steps to complete the activity using the program on the tablet, and finally putting the box to the shelf back after the activity ended. The practitioner faded the prompt out gradually as she thought the subject mastered the skill. For example, the practitioner who helped the subject select the activity on the table screen by holding his hand observed whether he selected the activity correctly in the next teaching session by holding his wrist instead. As the subjects mastered using the program, the practitioner rolled the help back to the level of being shadow. When all the subjects were able to run the program on the tablet and do the activity independently, the teaching sessions were ended.

Follow-up and Generalization Sessions

Follow-up data of the research were collected on the 7th, 14th, and 21st days after the teaching sessions ended, and all subjects emitted 100% correct response. Pre-test and post-test generalization data were collected before the teaching sessions began and after the teaching sessions ended for each subject. In the generalization sessions of the research, generalization data across materials and across environments were collected. After the teaching sessions of the research ended, data were collected in the play room of the educational institution of the subjects. A new schedule was created on the tablet computer program for the subjects to put four of the lego pieces of different colors in the play room together. Pre-test generalized correct responses were found 0% for all subjects, and post-test generalized correct responses were found 90% for Ali, and 100% for both Bora and Cem.

Social Validity

In the research, after the application ended, social validity data were collected from the teachers of the subjects. The teachers were shown the beginning levels of the subjects and the video recordings of the last teaching sessions, and then their opinions were asked. In order to collect the social validity data, a semi-structured interview form was prepared by the practitioner. There were five open-ended questions in the form. They were as follows: (a) You have watched the videos, what can you say about the performance of your student in the beginning and at the end of the application?, (b) What do you think are the positive aspects of this application?, (c) What do you think are the negative aspects of this application?, (d) What can you say about the use of the application in your class?, (e) What can you say about the use of the application at home? Collected social validity data were analyzed by using descriptive analysis technique.

Inter-Observer Agreement and Treatment Fidelity

In this research, inter-observer agreement data were collected for 40% of the sessions for each subject. Inter-observer agreement data were collected by a student who was conducting her doctoral research on special education and was experienced with teaching schedules by watching the session videos. An agreement was scored if both observers recorded a correct or incorrect response for the behavior chain. Inter-observer agreement was calculated by dividing the number of agreements by the number of agreements plus the number of disagreements, and by multiplying by 100 (O'Neill, McDonnell, Billingsley, & Jenson, 2011). Inter-observer agreement value of 100% was obtained for each subject in the research.

Treatment fidelity data of the research were collected for 40% of the sessions. In order to determine the treatment fidelity of the research, an observer watched the video recordings of selected sessions carefully, and evaluated the steps the practitioner followed using an unbiased assignment table. The observer put a "+" sign for each step the practitioner performed, and a "-" sign for each step she did not. The treatment fidelity steps used in this research were determined as follows: (a) arranging the tools and material, (b) preparing the reinforcements, (c) providing a prompt for focusing attention, (d) giving the initial instruction, (e) waiting for the response time, (f) manual guidance, (g) reinforcement, and (h) applying the prompt fading process. Treatment fidelity was calculated by dividing the number of observed practitioner responses by the number of expected practitioner responses, and by multiplying by 100 (O'Neill, McDonnell, Billingsley, & Jenson, 2011). Treatment fidelity of 100% was obtained for each subject in the research.

Conclusion, Discussion, and Recommendations

In this research, a tablet computer program was designed and developed in order for children with autism to use activity schedules via tablet computers. The program was studied by a practitioner with selected subjects. Research findings show that the subjects acquired the schedule following skills via the tablet computer program developed, and that they maintained and generalized this skill.

It is very important for children with autism to use schedules, one of the visual support systems, in order to develop skills like getting organized, acting independently, and making selections. There are several notable studies in the literature that have shown that schedules have had positive effects on the lives of children with autism (Hall et al., 1995; Krantz & McClannahan, 1993; 1998; Krantz et al., 1993; MacDuff et al., 1993; Stevenson et al., 2000). There has been a rapid increase in the number of studies involving computer-aided applications for children with autism recently, and positive results have been obtained in those studies. Especially it is seen that programs run on tablet computers have helped children with autism develop skills like social interaction and play with which they usually have great difficulty (Hourcade et al., 2012).

Results of the research were analyzed for the three subjects graphically in Figure 3. Correct response percentages of the subjects Ali, Bora, and Cem respectively were presented in the figure. As seen in Figure 3, number of teaching sessions is 8 for Ali, 7 for Bora, and 6 for Cem. Correct response rate of all the subjects raised from 0 to 100% level after the teaching sessions.

Results of this research where schedules were presented and used on a tablet computer show that all of the subjects learned to use schedules, and maintained and generalized this skill. In the literature, there are studies in which schedules were presented on portable devices, and these studies support the results of this research. Dauphin et al. (2004) studied activity schedules with a child with autism both on a laptop computer and with book format. Their results showed that the subject used activity schedules on the laptop computer with a higher rate of success than with the book format. In addition, findings of current research show consistency with another research where activity schedules were studied with children with autism via portable devices (Carlile et al., 2013). In that research, activity schedules were taught via an iPod Touch, a portable device, using graduated guidance technique, similar to the current research. When the programs used are compared, however, it is seen that, in the iPod Touch program, there is no such facility that all activity pictures are displayed on the screen together and the subjects can put a completion mark on the completed activities while following the activity sequence. In the current research, on the other hand, the developed program allows subjects to put a completion mark on the completed activities and to advance to the next one.

The research obtained similar findings as the other studies that used a teaching method with graduated guidance in schedule use (McClannahan & Krantz, 1999). Brayn and Gast (2000) examined the effectiveness of picture activity schedules for high-functioning children with autism to be interested in the schedule and to be interested in the activity. In a study by Morrison, Sainato, Benchaaban, and Endo (2002) play skills and on-task behavior of four children with autism, and the effects of activity schedules were examined. Graduated guidance technique had positive effects on subjects' acquisition of the target skill in both studies.

It has been supported by several researches that teaching with graduated guidance is an effective method for teaching several behaviors. In the literature, it is seen that graduated guidance has been implemented with technology-aided practices, however, there are a limited number of studies that had practices that provided visual support to the use of schedules (Dauphin et. al., 2004; Kimball, Kinney, Taylor, & Stromer, 2003; 2004). All these studies emphasize that the number of such studies needs to increase.

According to the results obtained from the social validity data of the research, it was noted by the teachers of the subjects that the tablet computer program could be used for other skills. It was also specified that the best aspects of the research was that the program could be used for other skills, that it was very easy to create activity steps by taking and using a photo, and that it was possible to give education anywhere with a portable device like a tablet computer. As a negative aspect, on the other hand, it was expressed that it might be a problem for the parents of the students to afford a tablet computer, thus, not giving an opportunity to every student to use the program everywhere. The authors' opinion about this issue is that tablet computers that can run the program are sold with relatively low prices, and as a result, they are more widespread and accessible than conventional desktop or laptop computers. The program was also made available free of charge by the authors. Therefore, the parents need not worry about the total affordability of a tablet computer and the program.

The study was effective for the subjects, and the underlying reason to this success can be that tablet computers draw the attention of children with autism more than any other teaching material. On the other hand, there are some issues that pose limitations to the research. First, single opportunity method was used for evaluating the performance of the subjects. When the single opportunity method was applied, it was not possible to demonstrate the performance of the subjects realistically. As a result, what kind of incorrect responses the subjects gave while teaching the skills could not be determined. A final limitation is that the social validity data were collected only from the teachers of the subjects.

Based on the literature and research results it is possible to provide recommendations regarding future research. First, number of studies involving tablet computers can be increased because tablet computers appear to be an effective tool in the education of children with autism. Second, more tablet computer programs can be designed and developed for the skills that children with autism have usually difficulty with.

It is also possible to offer recommendations regarding practice. The activity schedule program developed by the researchers can be practiced with children of different disability groups. In addition, the program can be used for teaching different skills like social interaction, communication, and academic skills to children with autism.

Acknowledgement

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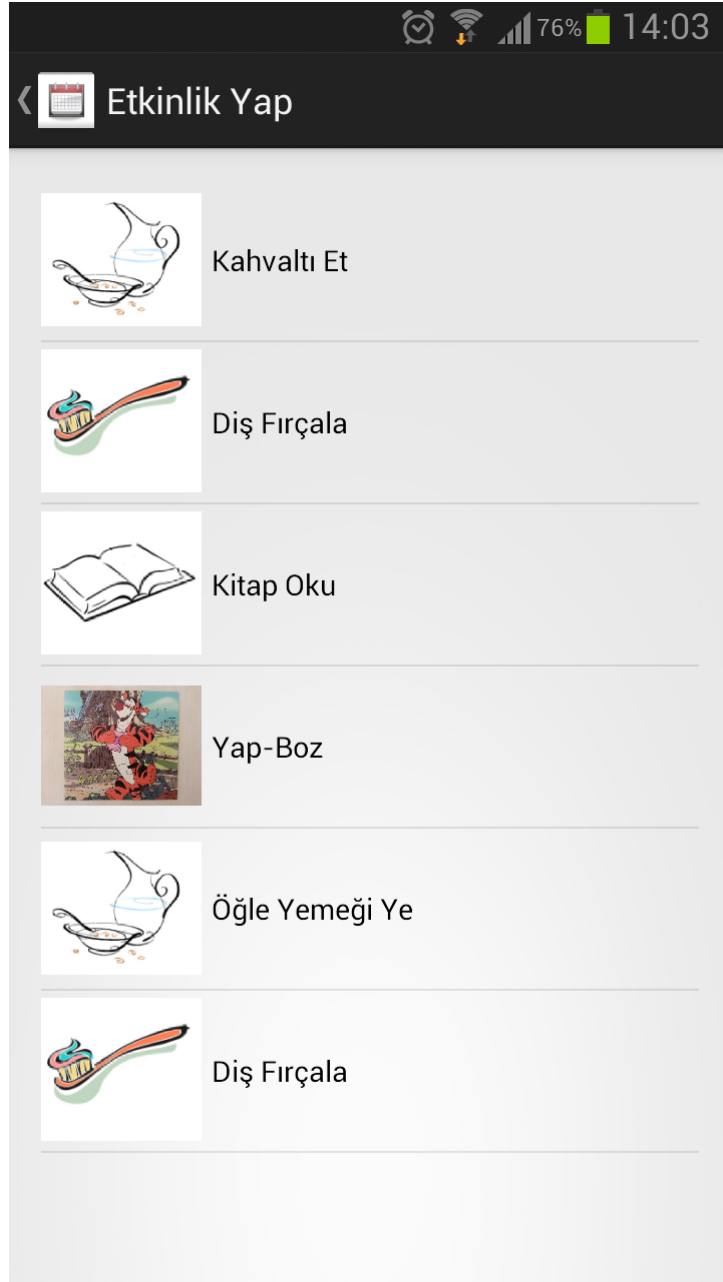
Appendix 1

Figure 1. List of Activities on The Tablet Computer Software
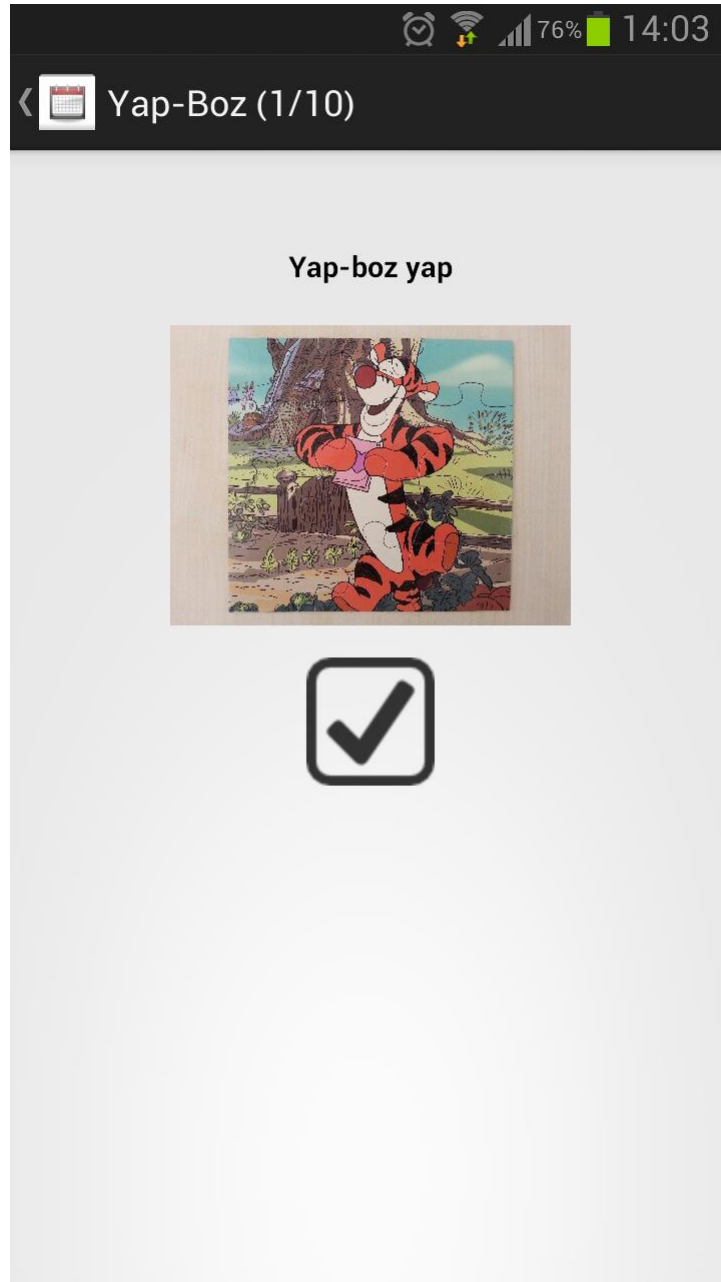
Appendix 2

Figure 2. The Puzzle Activity Chosen for Teaching The Subjects to Use Schedules in This Research
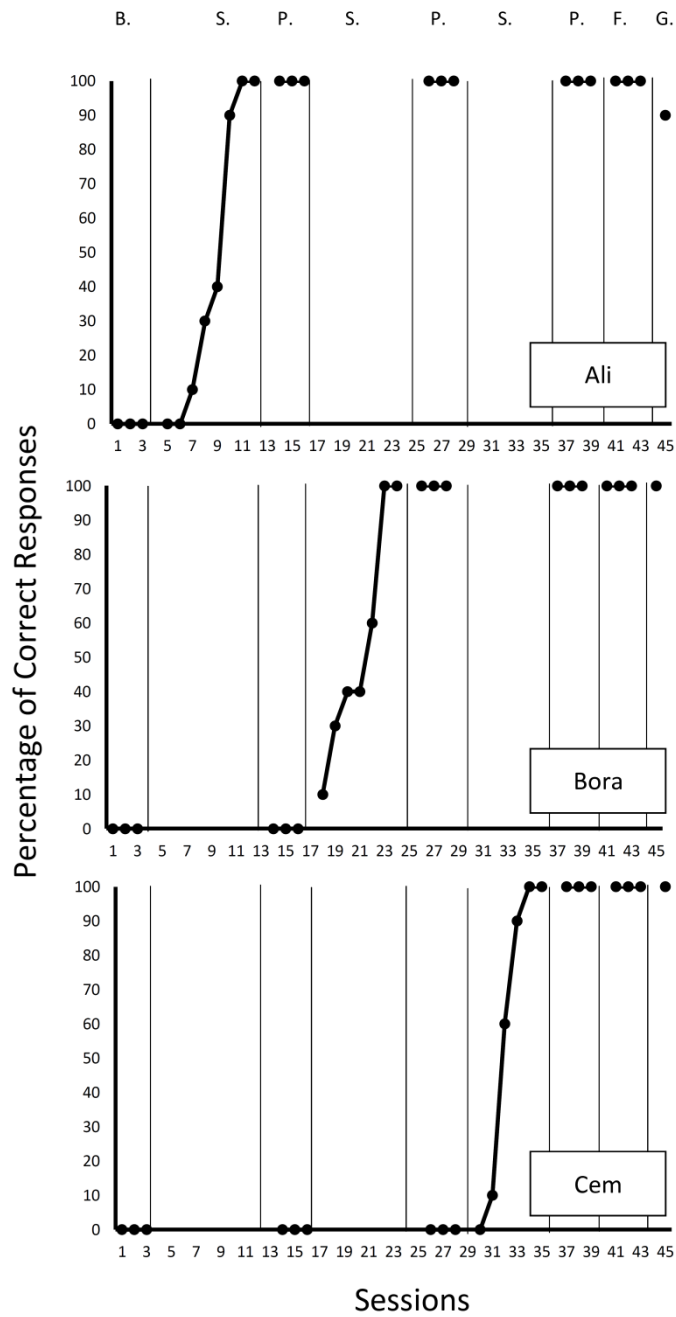
Appendix 3

Fügure 3. Graphical Analysis of The Subjects' Acquisition Level of Schedule-Following Skill.
B=Baseline; S=Sessions; P=Probes; F=Follow-ups; G=Generalization.